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INTERNATIONAL CENTER FOR AGRICULTURE RESEARCH IN THE DRY AREAS JOB #9 FINAL REPORT

**RAMP-CLIN 0002-JO# 9-0002-ICARDA
RAMP/ICARDA**



**Rebuilding Agricultural Markets Program (RAMP)
Job Order # 9**

**Introducing Protected Agriculture for Cash Crop Production in
Marginal and Water Deficit Areas of Afghanistan**

Final Report

1st Jan 2004 – 31st March 2006

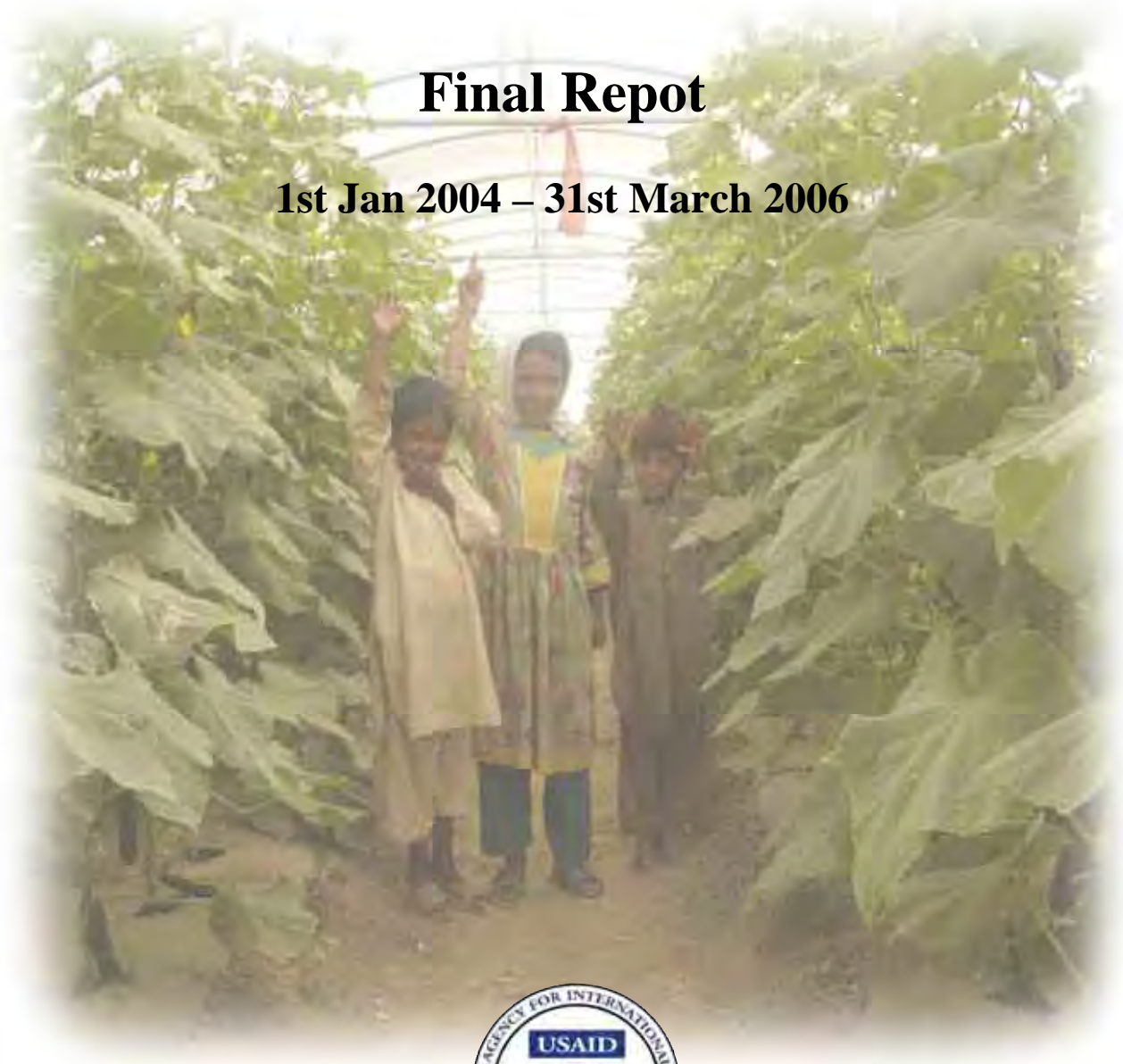


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1. Job Order Number: 9

Title:

Introducing Protected Agriculture for Cash Crop Production in Marginal and Water Deficit Areas of Afghanistan

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3. Contract Line Item Number (CLIN)

4. Report Period:

1st Jan 2004 – 31st March 2006

5. Total Project Budget:

US \$ 1,624,845, Cut down by Chemonics to 1,279,682

6. Summary of Project Activities and Impact

The implementation of the project was based on the approved schedule (Annex 1) for two and half years of activities which resulted in the following achievements:

- Protected Agriculture Center (PAC) is established in Kabul;
- Thirty five (35) greenhouses installed at farmers' sites in the provinces of Kunduz, Ghazni, Parwan, Nangarhar, Kabul, and Helmand;
- Eighteen (18) training courses organized on the following subject: greenhouse manufacturing, installation of GH; GH Management & Integrated Production and Protection Management (IPPM);
- 3 on-the-job training courses were organized outside of Afghanistan, at the Bossaily TC in Egypt and Rumais Research Center in Oman for 3 weeks each;
- 6 workshops/seminars organized for policymakers, ministry technical staff, NGOs and farmers;
- Seven Farmers' Field Schools (FFS) organized for practical sessions and experiences sharing among current and potential growers in the six provinces;
- Eight training manuals on greenhouse installation, climate control, irrigation & fertigation, management of drip irrigation, nursery preparation & production for cash crops and vegetable production in GH were prepared, translated into local languages and distributed to trainees;
- Hundreds of beneficiaries including farmers, Ministry staff and NGO personnel were trained;
- A market database established for seven greenhouse crops: egg plant, tomato, pepper, sweet pepper, cucumber, squash, and green beans.
- Bench Mark study have been carries out for pilot growers followed by Annual socio-economic study.

The impact of the greenhouse technology on growers' incomes was assessed. With only one exception, all pilot growers have not changed their cropping patterns, the number of crop or the size of land they use to cultivate prior to adoption of protected agriculture. Therefore, for

these farmers the greenhouses were add-ons to the portfolio of crops they used to grow and incomes. The level of income varies tremendously among the pilot growers, from as little as Afs 32,000 to Afs 2,750,000 per year. As such the basis for assessing PA contribution is not the same. Results show that greenhouse structure contributed between 8% and 138% increase in income generated from crop production in 2005. This has somehow catalyzed the interest of these farmers who expressed their willingness to accept more structures anytime from now.

Based on current greenhouse investment and crop production costs the profitability as well as water, land, and labor use efficiency parameters were estimated for comparison between open field and greenhouse productions on one Jerib of land. In consideration of adequate spacing and ventilation, it is projected that 6 greenhouse structures could fit on 1 Jerib of land. It is assumed that open field cultivation uses at least 10 times the volume of water required under greenhouse production. Results in following table show the superiority of greenhouse technology for cucumber production to the alternative, even though it requires some investment and high working capital. Total income generated under greenhouse is 6 times higher and the net income 4 times higher than what is obtained in open field per Jerib of land. This is a tremendous advantage given that greenhouses can be installed on marginal lands with very low rental value in rural areas. Compared to arable land rent charge of Afs 800 per Jerib (normally paid in kind: 70 kg for one Jerib) charged in some communities in Ghazni for example, greenhouse represents an excellent opportunity for income generation of farmers. Similarly, the return to labor is 69% higher under greenhouse cultivation with a substantial water saving.

*Comparison of profitability of cucumber production under
greenhouse and in open field (1 Jerib)*

Item description	Unit	Greenhouse (GH) Production ¹	Open field (OF) Production	Net change GH over OF (%)
Production ²	kg	19,500	3,700	427
Producer price ³	Afs /kg	24	18	33
Material input cost	Afs	118,200	4,650	2,442
Labor costs	Afs	76,800	18,000	184
Depreciation /season	Afs	60,000	-	
Total production cost	Afs	255,000	22,650	913
Total income	Afs	468,000	66,600	603
Net income /return to land	Afs	213,000	43,950	443
Yield per unit of land	MT /Jerib	20	3.7	427
Water efficiency⁴	kg /m ³	18	2.1	778
Net return to labor & management	Afs /man-day	1,166	688	69
Net return per unit of water	Afs / m ³	221	24	805

Data source: information obtained on spring production of cucumbers from the grower in Parwan.

1. For adequate spacing and ventilation 6 greenhouses could fit on 1 Jerib of land.
2. Open field cucumbers are longer and bigger than those being produced in greenhouses due to variety difference; accordingly 6 open field cucumbers weigh 1 Kg while 8 greenhouse cucumbers weigh 1 Kg.
3. Cucumbers are sold per unit not per kilogram; greenhouse cucumber carries a price premium for quality.
4. Assume open field uses 10 times more water than greenhouse cucumber production.

Protected agriculture was very promising with respect to the use of marginal land, labor and water, and had effectively made positive impacts on the income generation capacity of many growers. There is substantial evidence that the technology is economically viable in the context of Afghanistan. For example, cucumber production in the past spring season generated additional farm income of Afs 13,200 to 78,000 per grower, and net income (above total production costs) ranging from a moderate loss into positive territory that is as high as

Afs 35,500. Therefore, success levels vary among growers. For example, Mr. Mula Dad is a 28 years old grower from Parwan province who has so far made the highest income from greenhouse production of cucumber in Afghanistan during the March-August 2005 season. He used to work with his father within an extended family, and his father was financially responsible for all members. A couple of years ago his father decided to share his land among him and three other brothers. He received 1 Jerib of land and cultivated wheat and turnip in rotation before his exposure to the greenhouse technology. Married with 2 children, Mr. Mula Dad has been working as a labor in the construction sector; his income was not only volatile but also very low (about Afs 2,000 per month). During his first season, he produced about 26,000 cucumbers from his 270m² greenhouse and sold them at Afs 3 per cucumber on average. He remembers that he earned at least Afs 60,000 cash from this activity (some cucumbers were given to friends and visitors) which he spent on his family and has a small saving. Now the power centre in the extended family shifted onto him because of improvement in his financial status. He declared that if he had money he will invest it in the greenhouse and he is ready to fit as many greenhouses as possible on his land. It is worth mentioning that Mr. Mula Dad participated in numerous training courses (in Afghanistan and Cairo) and farmers' field schools organized by the project.

The PA project has achieved impressive results compared to the milestones set for the end of the second year. The efforts invested in its implementation are paying off as many potential growers are attracted to the greenhouse technology and are willing to adopt or at least try it. Generally, growers' performance with protected agriculture is mixed as one would expect from any new technology; some are picking up quickly and easily the techniques, doing well whereas others are not. There are indications that the advantages of PA technology are being felt in the six provinces and beyond in terms of labor, land and water use efficiency as well as income generation. Farmers and other stakeholders have generally a good perception of the PA technology amid some constraints such as controlling the temperature, humidity, pest or diseases, and soil preparation before planting. Similarly, the issue of credit or financial support towards acquiring the greenhouse structure, availability of construction materials and specialized inputs are extremely important and should be addressed to achieve a wide adoption of the technology. There is a need for continued and more frequent visit for technical support to pilot growers who are currently experiencing this technology. Accordingly, growers' success was mainly related to technical backstopping received from ICARDA. Their success will determines the future of the technology and the extent to which it could contribute to the ultimate goals of increased productivity, food security, and improved livelihoods in each community with spillover effects that have positive impacts on the Afghan economy as a whole.

7. Task Completed During Reporting Period

7.1. Protected Agriculture Center in Kabul

Introduction

Protected agriculture (PA) is a relatively new agro-industry in Afghanistan. It is, therefore, important to demonstrate to growers, Government officials, NGO personnel and other stakeholders the potential of PA and all other associated practices such as drip irrigation, plant nursery management, integrated production and protection management (IPPM) practices and crop handling. This is why a Protected Agriculture Center (PAC) has been established in Kabul. The PAC would serve as a:

- demonstration unit for the production of high-value crops under GHs,
- training center for growers, extension agents, agriculture engineers and NGO personnel in all protected agriculture aspects and techniques,

- central point for technical support and advisory services in protected agriculture, and
- research center for problem solving on protected agriculture.

Selection of sites and land preparation

The site of Badam Baugh Research Center (BBRS) was carefully studied by the scientists in coordination with the BBRS management and the suitable area for establishing the greenhouse (GH) was selected. The area was planted with potato at the time. The machinery department of the Ministry of Agriculture and Livestock (MAAH) was contacted to provide the necessary machinery for cleaning and leveling the selected area (90m X 45 m), located adjacent to the main entrance road.

Installing and assembling of the GH

Installation work for the GH (single span plastic cover Greenhouse) started on 27 July 2004 and followed the steps below:

1. Decision on the direction and orientation of the GH;
2. Layout and marking GH location;
3. Digging for GH foundation;
4. Assembling and installation of GHs Steel Structure;
5. Covering GHs

Four GHs were installed at PAC with dimension of L 30m x W 9m. Local counterpart and technician were involved in the GH installation and assembly.

Water source and irrigation

Water for the selected area was provided from two wells connected to a storage tank to feed GHs with the required water for irrigation by gravity. A new single phase submersible pump was installed on the well allocated within the GH area with the capacity of 300Hp and 2.2 Kw. The depth of the well was 45m and the pump fitted at 35m depths. New pipe connections and a water tank on elevated support (ca. 4m) were fitted to ensure adequate pressure.



Installation of water tank and support

GH irrigation and fertigation

A drip irrigation system was installed in each GH which consists of 8 drip irrigation lines with drippers at 20 cm apart. The 8 drip lines were connected to sub-main line. A fertigation unit was assembled for each GH which consists of fertilizer tank, screen filter and valves.



Irrigation system

Planting

Vegetable seeds (tomato, sweet pepper and cucumber) were sown in seed trays using mixture of Peat Moss and Perlite (2:1). After germination young plants were transplanted to the growing beds in the GHs. The growing beds were of 28m length to accommodate 136 plants in two lines. The total numbers of plants in the GH were 544 plants to provide plant density of 2 plants/m².

Production

The first harvest of cucumber at PAC occurred on 10 Sep 2004. The production period lasted for 75 days with total yield of 1700 Kg sold at about 55,000 AF = US\$1280.

7.2. GH Manufacturing Workshop

The GH manufacturing workshop (GHMW) was established at PAC with full range of modern equipments for manufacturing GH structures. During the project implementation phase the GHMW produced more than 63 GHs and was used as training facilities for training the local fabricators on GH manufacturing.



Greenhouse Manufacturing Workshop, PAC, Kabul in full operation

The workshop's equipment and machinery were completed with a Tube Scroller machine which had been designed and manufactured at ICARDA, Aleppo and was shipped to Kabul and installed at PAC.

Manufacturing the GH's structure at the GHMW, significantly reduced the cost of the GH by 20% in addition to the saving from shipment cost from outside Afghanistan.

About 15 Afghan technicians have been trained on manufacturing GH structure during the project at GHMW.

7.3. Establishment of Greenhouse Facilities in Farmers' Fields

The project was designed with the major activities to promote the adoption of affordable and sustainable protected agricultural systems to produce high-value crops, using marginal or otherwise non-productive lands and water more efficiently, by installing simple greenhouse structures at selected pilot sites with participating farmers. The criteria for selecting farmers were based on group discussions and farmers' meetings in which the concept of the project was discussed. Participating farmers were from the active segments of the farming community. Contacts were made with the head of the extension department and other concerned departments within the MAI to assist with the selections.

The project target was to establish 28 GH at selected private farms. The total number installed by the project were 35 GH with an increased of 40% over the project target. This in addition to 30 GHs established in Kunduz, Baghlan & Takhar at the cost sharing bases with the growers. The installation of GHs started early July 2004. The single span GH with a dimension of 9 m wide and 30 m long was the standard design implemented by the project. All GH were equipped with drip irrigation & fertigation systems.

During the establishment, target farmers and their neighbors were involved in all steps of GH installation which was considered as practical training. The following table illustrates number & location of each GH installed by the project.

Province	District	# Green houses Established	
Ghazni	Center	4	
	Khoja Omari	1	
	Qarabagh	1	
	Sub Total	6	
Helmand	Center	3	
	Greshk	1	
	Nad Ali	1	
	Nawa	1	
	Sub Total	6	
Kunduz	Aliabad	2	
	Center	1	
	Chardarah	2	
	Imam sahib	1	
	Sub total	6	
Parwan	Charikar(Center)	3	
	Jabalsaraj	1	
	Bagram	2	
	Sub total	6	
Nangarhar	Behsoud	1	
	Surkhroud	3	
	Center	2	
	Sab total	6	
Kabul	Bagrami	1	
	Chardehi	1	
	Charasiab	1	
	Shakardara	1	
	Deh-Sabz	1	
	Sub total	5	
Grand Total		35	



Growers received technical training on GH preparation and cultivation of different high value crops i.e. Cucumber, Tomato, Lettuce, Peppers, and Musk Melons etc... The following table is showing the production and income of cucumber produced recorded during 2005 in different provinces.

Average yield and income of cucumber in 5 targeted provinces during two growing seasons, May-Jul & Aug-Nov, 2005

Province	# GH	Total Areas (m²)	NO of Cucumbers	Total Weight (Kg)	Total income (Af)
Kabul	5	1350	24026	7645	119,259
Kunduz	6	1320	65992	21000	329,960
Nangarhar	3	780	26392	3700	167,157
Parwan	6	1320	45208	14384	297,827
Helmand	6	1248	15593	5570	60,287
Ghazni	6	1248	15560	4903	73,945
Total	32	7266	192771	57202	1,048,435

7.4. Capacity Building and Training

7.4.1. Training

Numbers of special training courses were carried out by the project to technically empower the Afghan growers, extension agents and researchers for the production of high quality cash crops under PA with less water. In addition, on-the-job training programs were implemented for farmers, national agricultural research staff, extension agents, and technicians within Afghanistan and in leading farms/Research Centers outside Afghanistan.

The total number of growers, extension agents, researchers and NGO personnel trained by the project is 364 which show 40% higher than project targeted number of 264.

Training of Trainers

A number of specialized class room and field practice training courses were carried out for training the local trainers. These courses targeted qualified horticulturists and extension agents from the MAI, NGOs and the local counterpart personnel involved in this project.

Training for Growers

Growers received on-the – job training on their farms and at PAC. During the different seasons and stages of crop growth and development, growers have been gathered in PAC for more detailed practical training.

The followings are the main components of the above mentioned training courses:

- A. Greenhouses and cover materials
 - Types of greenhouses
 - Plastic house and low tunnels installations
 - Types of cover materials, insect proof nets and shading materials
 - Modern irrigation and Fertigation system and management
- B. Green House Preparation
 - Setup the irrigation / Fertigation system
 - Growing Medium
 - Layout and Plant density
- C. Nursery
 - Preparation & Protection
 - Growing Medium & Containers
 - Sowing Techniques
 - Production of seedlings using plugs techniques, soilless, etc.
 - Hardening off and transplantation
- D. Integrated Production & protection Management (IPPM)
 - GH environmental control and mechanical protection
 - Crop Management during the vegetative and production stages
 - Irrigation and fertilizer requirements and scheduling
 - Safe and efficient use of agriculture Chemicals
 - Biological Control
 - Soil Sterilization including Solarization
 - Identifications of major pest and diseases
- E. Production of different crops under plastic houses
 - Tomato, Cucumber, Peppers, Strawberry, Musk melon, Lettuce
- F. Pre and Post Harvesting techniques
- G. Maintenance of plastic houses and irrigation

The project implemented a total of 18 training courses including three on-the-job training courses on GH Management & IPPM in leading Farms and Research Stations outside Afghanistan. The trainees consist of growers, extension agents, researchers from the MAI and NGOs.

List of the Training courses:

Date	Title	Participants	Location
26-30 July 2004	GH installation and preparation for cash crop production (Trainers)	22	PAC, Kabul
1-5 August 2004	GH installation and preparation for cash crop production (Growers)	20	PAC, Kabul
13-16 Dec 2004	Integrated production and protection management (IPPM) for protected agriculture (growers)	16	PAC, Kabul
20-23 Dec 2004	Integrated production and protection management (IPPM) for protected agriculture (Trainers)	24	PAC, Kabul
14-15 March 2005	GH installation and preparation (trainers & Growers)	40	PAC, Kabul
16-17 March 2005	integrated production and protection management (IPPM) (Trainers & Growers)	40	PAC, Kabul
19-30 March 2005	On-the-job training on GH installation and preparation (Growers & Extension Agents)	30	In 10 location in 5 targeted provinces
	Integrated production and protection management (IPPM) on farmers' fields (Growers & Extension Agents)		
1-10 March 2005	On-the-Job Training on GH Manufacturing	10	GHMW, PAC
13-15 Dec 2005	On-the-Job Training on GH Manufacturing	6	GHMW, PAC
5-7 July 2005	Advanced course on Integration Production and Protection Management (IPPM) (Growers)	25	PAC, Kabul Two training course were run separately in same time
	Advanced course on Integration Production and Protection Management (IPPM) (Trainers)	34	
25-27 Sep 2005	Advance Integrated Production and Protection & Protection Management (IPPM) for Cash Crops Production under the Protected Agriculture (Growers)	51	Kunduz Two training course were run separately in same time
	Advance Integrated Production and Protection & Protection Management (IPPM) for Cash Crops Production under the Protected Agriculture (Trainers)		
21- 27 April 2006	on-the-job training course on GH management and IPPM	30	Kunduz in 30 Location at Farmers fields
6 Feb. 13-Mar, 2005	On-the-job training course on Greenhouse management	4	ARC, Rumais Muscat, Oman
May 29-Jun 16 2005	On-the-Job training Course on Greenhouse Management	6	Al Bosaily training center, Egypt
3-21 Mar 2006	On-the-Job training Course on Greenhouse Management	6	Al Bosaily training center, Egypt
Total		364	

7.4.2. Farmers Field Schools (FFS)

FFS is an effective approach for technical education and capacity building for growers. The approach has been used successfully in the project. It provides a suitable environment for farmers to generate knowledge that is functional and necessary to improve their production skills. The following tables illustrate the number of participants and location of each FFS.

Date	# Participants	Location
6 Oct 2004	10	PAC, Kabul
19 Dec 2004	10	5 project sites at Kabul
27 April 2005	15	Charaiab, Kabul
30 April 2005	32	Qale Miri, Ghazni
2 Mar 2005	42	Charikar, Parwan
27 Sept 2005	30	3 pilot sites at Kunduz
1 Oct 2005	13	Gol-Bagh, Kabul
Total	152	

During the FFS, growers received technical information relates to the specific problems exists at the farmers fields. Suitable recommendations were delivered by ICARDA specialist to growers.

7.4.3. Protected Agriculture Workshops/Seminars

Protected Agriculture workshops & seminars have been organized on a regular basis throughout the project duration to which all stakeholders including growers, extension agents, researchers, NGO as well as high officials from MAI, ICARDA and donors participated. Major technical problems which were common between the growers and constrains for wider adoption also were discussed in details during the workshops.

The following table presenting the number of participants, dates and location of each workshop/seminars.

Date	# Participants	Location
18 Dec 2004	15	PAC, Kabul
27 Apr 2005	20	PAC, Kabul
30 Apr 2005	32	ICARDA Office, Ghazni
2 Mar 2005	42	ICARDA Office, Parwan
4 Jul 2005	60	MAI, Kabul
19 Mar 2006	65	Intercontinental Hotel, Kabul
Total	234	



On-the-job training course on GH manufacturing

7.5. Market and Socio-economic Studies

7.5.1. Market study

In order to understand the trends in demand, supply, and prices for different vegetable crops a market survey was conducted in Kabul.

The market survey was initiated in January 2004. The wholesalers and retailers in the central market for vegetable and fruit (VFM), Shahr-e-now, Mokruan, Pol-e-Kheshti and Kot-e-sangi vegetable market were visited.



Interview with wholesalers, retailers and farmers

The Marketing consultant was visited different organizations related to vegetable market and price control including:

- The Price Control and Marketing Department (PC&MD) of Kabul municipality
- Kabul Vegetable and Fruit Cooperation (KVFC)
- Individual growers

This provided a wider vision in the basic structure of the fruit and vegetable marketing in Kabul.

The Market Data were collected daily on a special form by a local person

Based on these data a computer database (using MS Access software) has been developed and installed at ICARDA office in Kabul. The database was updated regularly with the daily collected data. 22 months of data were collected and entered to data base.

Final report for market research study have been developed by ICARDA (see the Annex)

 Screenshot of the 'CASH CROP MARKET DATABASE FOR KABUL' software interface. The main window displays the ICARDA logo and project title. A 'Data Entry Form' is overlaid, containing fields for ID (AutoNumber), Date, Crop, Source, Unit, Outlet (Wholesaler), B-Price, B-qu, S-price, and S-qu. The form also includes buttons for 'Enter Data', 'Exit Data', 'Export Data', and 'Queries/Tables'.

7.5.2. Benchmark and socioeconomic study

The benchmark studies in the targeted areas and of selected pilot farmers were conducted to collect baseline information and appropriate performance indicators for monitoring and evaluation. Such indicators includes:

- Number of farmers participating in project:
- Number of farmers participating in training, workshops, demonstrations etc.
- Number of greenhouses and the area under greenhouses
- Yields, production costs, marketed surplus and net returns
- Returns to investment

A questioner was developed for benchmark survey and to collect data form the selected farmers.

The first benchmark surveys conducted during July 2004 for five pilot growers in Kabul (see the report as Annex). The second benchmark study for other growers in 5 targeted provinces were carried out through interviews during FFS, workshop & training courses in Kunduz & Kabul in Sep 2005.

Annul socio-economic study were conducted for all growers during Sep 2005. The study was focused on project progress indicators, achievements, impacts on growers' livelihood and to identify constrains against wider adoption. The report is published (please see Annex).

The final socio-economic study was due on July 2006 but due to early termination of the project the study could not be done and previous study to be considered as final.

7.6. Publications

Many publications were produced to describe the project activities and to help growers. Materials were published in English and Dari

7.6.1. Training manuals

Eight training manuals were developed and published on local language. The titles are as follow:

1. GH Installation & preparation
2. Nursery for GH Crops
3. Vegetable Production in GH
4. Integrated Production and Protection Management (IPPM)
5. GH Climate Control
6. Fertigation of GH Crops
7. Management of Drip Irrigation
8. Major pest and diseases of the GH crops



7.6.2. Posters

Three posters were developed for the project. These are consisting of:

1. Protected Agriculture Center (PAC) Established in Kabul Afghanistan



2. Response of Afghan Growers to Protected Agriculture in the First Season



3. Major Pest and diseases of the GH crops

7.6.3. Multi Media & Video clip

Establishment of Protected Agriculture Center at Kabul, Afghanistan



8. Lessons Learned and Recommendations for Future Activities

Protected agriculture has significant roll in increasing farmers' income in Afghanistan. Two examples of good grower's production during one year (two crop – cucumber) under PA in Afghanistan are Mr Mola Dad in Parwan and Mr Gous Moahmed in Kunduz. Both GH are 270 m² (9x30) and planted by Cucumber in last two growing seasons. Both growers were always participating in all training courses organized by the project. The tables below showing their production and income records in two seasons.

Parwan-Mr. Moala Dad

First Sason (19th May - 24 July)			Second Season (10 Oct to 24 Nov)			Total		
Total Production	Income (Af)	Income US\$	Total Production	Income (Af)	Income US\$	Total Production	Income (Af)	Income US\$
25000	72232	1444.64	7900	52760	1055.2	32900	124992	2499.84

Kunduz- Mr. Gous Mohamed

First Sason (16th Jun - 16 Aug)			Second Season (30 Sep to 30 Nov)			Total		
Total Production	Income (Af)*	Income US\$	Total Production	Income (Af)	Income US\$	Total Production	Income (Af)	Income US\$
12931	32327.5	646.55	15150	75750	1515	28081	108077.5	2161.55

**-Mr Gous Mohamed distributed his first production in the first seasons free within his family. The average price of cucumber during that period were calculated for the possible income of the distributed fruits*

Participation of growers in the training program and technical back stopping has a major roll in farmers' success and sustainability of the project.

Protected agriculture has the potential to contribute significantly to both the development of rural communities and to the Afghan economy. It can play an important role in supplying local markets with fresh produce that could not be grown otherwise, and in creating employment within rural communities and productive opportunities for the disadvantaged, particularly women, returning (landless) refugees and the disabled. It also offers potential for development of a private service sector in the construction and supply of protected agriculture equipment. Ultimately, high yielding quality produce from protected agriculture could be expanded to serve the export market and generate a valuable source of foreign revenue.

Moreover, on a small scale, the system can be managed by household labor alone, or on a larger scale can generate additional employment opportunities in the intensive management and care of protected crops. It particularly favors the involvement of woman, as it dose not require heavy labor, and provides an enclosed environment in which woman can work.

Protected Agriculture can play major roll in controlling poppy cultivation as an alternative livelihood. During a workshop on 2005 one of the growers from Helmand mentioned that he used to grow poppy. From each Jerib of poppy cultivation his benefit was about 450-500 US\$ per year, but from his 270m² GH his income was about 500US\$ in a one seasons. Further more working in GH is far easier than working for poppy field. He had decided to stop growing poppy.

Protected Agriculture could contribute on the alternative livelihood, institutional building (through improving human resources to insure the sustainability of the project) and at creating public awareness about GHs as alternative livelihood. Based on the studies carried out in Afghanistan, the main factor which is forcing farmers to grow poppy is its economic value and the credit facility for pre- sale.

In areas of Afghanistan where arable land is limited and water is scarce, protected agriculture offers an opportunity for vertical expansion and for generating returns per unit of land and of water from the production of high value crops, which would represent an attractive alternative.

9. Performance Indicator Report

Compared to the milestones to be achieved by the end of the project, the achievements as summarized in the following table are commendable.

Performance Indicator	Milestone		
	Target	Achievements	%
Protected Agriculture Center	1	1	100
Pilot farm greenhouses	28	34	121
Training courses	21	18	86
Farmers Field School	6	7	117
Number of trainees	264	364	138
Market database for greenhouse crops	1	1	100
Training manuals	4	8	200
Socio-economic & Bench mark study	3	2	67
Overall Average			116

The project target indicators initially have been set for a three years project, but due to severe cut in budget the project closed earlier. Despite of cutting in budget and duration, the project managed to achievement in many cases more than what have mentioned in the project documents.

10. Summary of Projects Relationship and Coordination with the Transitional Islamic State of Afghanistan and Appropriate Ministries during the Course of this Project.

The project had a close relationship with the MAI since the beginning with Ministry officials were involved in the development the project work plan and during implementation phase. ICARDA vision as International Research Center in all activities and project around the world is to keep close relation with NARS and to increase the capacity of local counter parts.

The project had always received good support from government officials in Kabul and project targeted provinces. The pilot GHs and PAC have been visited several times by these officials. Governor and Deputy Governor of Parwan & Kunduz respectively officially send supporting letter to ICARDA management (see the Annex).

The project relation with the MAI as representative of Afghanistan government could summarized as following:

10.1. Training of the MAI personnel

In all the training and capacity building activities number of MAI personnel from Extension and Research department were participated. MAI personnel specially have been involved in the training of trainer program. This helped the sustainability of the project for transferring the technology.

The extension agents and researcher also accompanied ICARDA consultant and specialists during FFS, workshops and field days.

10.2. Establishment of Protected Agriculture Center (PAC) through a MOU between ICARDA & MAI

A Memorandum of Understanding (MOU) has been signed between ICARDA and MAI for establishment of Protected Agriculture Center (PAC) at Badam Baugh ARC in Kabul. The MOU were signed by Prof. Dr Adel El Beltagy, ICARDA Director General and H.E. Sayed Hossein Anvary, Minister of Agriculture & Irrigation on 25 April 2004 at ICARDA HQ.

Through this MOU, MAI and ICARDA agreed upon

- PAC to be established at Badam Baugh ARC by ICARDA. PAC would stay in ICARDA control during the implementation phase of the project for implementing training courses, manufacturing GH structures and as a central point for coordinating project activities in other project targeted provinces.
- MAI would be responsible for the security of the center and its assets
- PAC with all its assets including Greenhouse Manufacturing Workshop and Cash crops production facilities would be transfer to MAI by the end of the project.



H.E. Ubaidullah Ramin, Minister, MAI and H.E. Mr. Javad Deputy Minister, MAI during an official visit to PAC at Feb 2006. from right H.E. Mr. Javad Deputy Minister; Prof Dr. Magdy Madkour, ADG-IC, ICARDA, H.E. Ubaidullah Ramin, Minister; and Dr Ahmed Moustafa, PA specialists and project PI, ICARDA

10.3. Installing two GHs at the GH at MAI

As agreement between H.E. Ubaidullah Ramin, Afghanistan's Minister of Agriculture and Irrigation and ICARDA two GHs were installed at the MAI site. ICARDA consultants visited the proposed sites in the Ministry to measure the area and decide on GH structure type. The GH pipes and fittings were designed and manufactured at PAC Workshop according to the drawing. The two GHs were shipped to the Ministry. The dimension of the first GH was 9 m width 26 m length and 3.25 m height, whereas the smallest GH was 7 m width, 14 m length and 3.75 m height. Pepper and tomato plants of 50 days were transplanted in plastic bags (10 L volume) at PAC to be ready for planting at MAAF.



Installing two GHs in MAAF, Kabul

11. Photographs, Human Interest and Beneficiary Stories

11.1. Response of Afghan Growers to Protected Agriculture after the first season

H.E. Mr. Mohammad Sharif,
Deputy Minister, Ministry of Agriculture, Animal Husbandry & Food (MAAF)

Protected agriculture help growers to generate more income

In the ministry, we are trying to modernize the agriculture sector. ICARDA has helped us to adopt the new technology of protected agriculture since last year. They established a centre in Badam Bag. I have seen the greenhouse (GH) in Kunduz Province in a private farm producing cucumber. This will help growers to generate more income. All of you should learn this technology and also teach other growers. Each agriculture cooperatives should have at least one GH. We can construct the GHs on a small piece of land and it is very easy for our families and rural women to work inside them to produce cash crops for the market



H.E. Abdul Jabar Tagva,
Governor of Parwan Province

Protected Agriculture has brought new hope to Afghan Growers

I thank God that our country after years of war is starting a new age of development and growth. Establishment of these greenhouses was a very good step towards agricultural development and provides the Parwan growers with new hope for a better future. I appreciate all the efforts and dedication of ICARDA for establishing these GHs which are in production now. I hope that this great movement will expand across Afghanistan, especially in Parwan province to help growers who lost everything during the war.



Mr. Aga Ghol,
Grower from Helmand

Cucumber from open field is finished but my GH is still giving me Cucumber

My GH area is about 300 m² and I produce 9000 cucumbers. Right now in Helmand there is no cucumber from open fields (recorded July 05), but my Green House(270 m²) still producing and has given me the same yield I usually get from 2 Jerib (1 Jerib=2000 m²). Look at my notebook; this is my yield which I have sold for 19500 Afghani (\$390).

Mr Mohamed,

Grower from Kunduz

All my neighbours are asking for GH to buy

...I have so far harvested 9000 cucumbers. The plants are very healthy and I have no problem inside my plastic house. I am expecting about 1500-2000 more cucumbers to be harvested. When I installed the plastic house, my neighbours were suspicious, but now they wish to have a Green House in their farm.

The Governor of Kunduz and many growers visited my Green House and tasted my cucumber.

Mr. Abdul Ahead,

Grower from Nangehar

I sold my cucumbers for US\$400

...brothers, let me tell you (reaching out for paper from his pocket). In my plastic house, I had only 380 plants because the frost killed the rest but I harvested 9950 cucumbers sold at 20290 Afghani (\$400). I planted my seeds on 23 March and on 20 April transplanted to the plastic house. I harvested 10 times, started from 26 May until 27 June. I was checking my Green House everyday and had no problem with pests.

Mr. Ahmedyar

Head of Extension, Ghazni

All growers show interest in Protected Agriculture

All the growers show interest in the GHs. We implemented a field day in collaboration with ICARDA coordinator in Ghazni to introduce GH to the growers. The field day was covered by the local TV and news papers. Many growers came to us later to investigate and requested GH. I would like to suggest that these activities be organized through our extension agents in collaboration with ICARDA in the provinces.

Mr Mohamed Qasim

Grower from Helmand

From one Jerib of opium we earn \$400-450. The income from this cucumber is more than from one Jerib of opium.

I am from Helmand where most of farmers grow opium. From one Jerib of opium we make \$400-450 profit, but the government has prohibited growing opium. This year I have one Green House in my farm and it produced 8500 cucumbers. The income from this cucumber is more than one Jerib of opium.

For opium, we can produce one crop per year and requires lots of labour, while we can produce 2-3 crops of cucumber from Green House on small land with less labour and more income. I think if you give farmers a Green House they will stop growing opium.

Mr. Moladad,

Grower from Parwan

My Green House produced 12200 cucumbers sold at 3-4 times more than open field

From my plastic house, I have so far produced 12200 cucumbers and I am expecting 7000-8000 more cucumbers. I harvest cucumbers 2-3 times every week. I don't have any problems with pests and diseases. The prices of my cucumber are 3-4 times more than that from open field.

ICARDA sent me to Egypt for training on GH Management. I learned and gained valuable knowledge in GH management which I will share with other growers in Afghanistan.

Mr Zarif,
Grower from Nanghar

Last year I could not make even 15000 Afghani from one Jerib of cucumber, but this year I made 20000 Afghani from one Green House(270 m²).

There are two GH installed in Nanghar province. Each of them is 270 m². We harvested 9970 cucumbers from the first GH and sold them at about US\$400. The yield of the second Green House was 9060 cucumber sold at 13500 Afghani (about US\$280). Comparing to the open field crop, farmers' income was 2-3 times more.

This greenhouse technology has benefited us. Last year I could not make even 15000 Afghani from one Jerib of cucumber, but this year I made 20000 Afghani from one Green House(270 m²). All my neighbouring farmers wish to install plastic houses on their farms after they saw my cucumber. They are willing to meet some of the costs.

11.2. Deputy Governor of Kunduz letter to ICARDA DG

Prof. Dr Adel El Beltagy
Director General, ICARDA

Dear Dr El Beltagy
After compliments

Thank God that after so many years of unwanted war, I can clearly see a new horizon toward development in Kunduz province. The efforts of your staff who work day and night for transferring new technologies to Afghan growers are exceptional.

The efforts which were made to introduce cash crop production under protected agriculture have drawn a great interest among the Kunduz growers. Different training courses which were organized for Growers, Extension Agents and other related staff in Kunduz and other part of Afghanistan, helped a lot in transferring this technology. Establishment of green houses in farmer's field shows great responses from the growers after the first production season due to the high income they generated. These green houses have increased the farmer's income and made new hopes for them.

I feel necessary to acknowledge the efforts of ICARDA and the supports of USAID that made this success possible. Now, we have many growers interested in this production technique. I hope with your support and special attention, this program will be developed further and will sustainable in Afghanistan especially in this province.

Sincerely

Sayed M. Dawoud Hashmi

Deputy Governor
Kunduz Province
Islamic Republic of Afghanistan



11.3. Pictures & Photos

Establish of PAC



Badam Bag RS in 26th July 2004. Right site of the road which had been selected for installation of GH was under potato cultivation



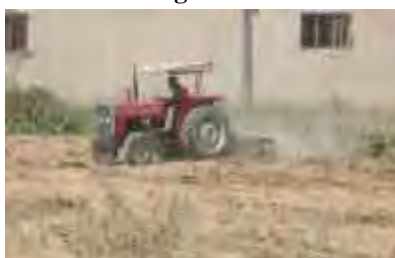
The site of BBRs was carefully studied by the scientists in coordination with the BBRs management



Protected Agriculture Center (PAC) in 20 March 2005. From right: GH manufacturing workshop, water pump and tank, four GHs and the building in left is PAC office, classrooms and store



Land preparation and leveling by tractor



Measuring and layout of the GHs



Assembling the arches



Assembling the foundation pipes and aligning them





Erecting the arches



Supporting wires



Covering with plastic



Four GH in the PAC



Preparing the growing media and sowing in seed trays



Preparing growing beds and transplanting



H.E. Sharif, Deputy Minister, MAI visited PAC to witness the first production of cucumber, tomato and lettuce crops.

Establish GH at Farmers Fields



Leveling and site preparation



GH layout



Digging and foundation



Foundation



Preparing the arches



Erecting the arches



Interconnections and wiring





Cucumber production at farmers fields

Capacity Building, Training, Workshops & Seminars



H.E. Mohamed Sharif, Deputy Minister, MAI inaugurating a training course (left) on GH Management & IPPM, March 2005. Some of the participants in the training course (right)



Training course on GH installation and preparation July 2004



Practical sessions



Lecture sessions



Participants in the first TC after covering the first GH





Practical sessions, IPPM TC, Dec 2004



H.E Sharif, Deputy Minister, MAI, inaugurating the workshop, Dec 2004



Experts from different project stakeholder participated in the first workshop at PAC, Dec 2004



FFS 19 Dec 2004



Training Course on GH Management & IPPM, 6 Feb – 13 March, Rumais ARC Oman



Training Course on GH Management & IPPM, Al Bossaily training center, Egypt, May 29-Jun 16 2005





GH installation & Preparation training course, March 2005



IPPM and GH installation Training course at farmers fields



Protected Agriculture Workshop, Kabul Feb 2006



Group discussions with farmers



FFS and practical training at farmers fields, Kunduz, Sep 2005

Annexes

- **Project Time schedule of activities**
- **Socio-economic Assessment to Monitor Progress Against Baseline Indicators, Farmers Perceptions and Potential Constrains to Wider Adoption of Protected Agriculture (PA) Technology in Afghanistan**
- **Vegetable Price Analysis and Marketing Windows for Protected Agriculture Technology Adopters in Afghanistan**

Annex 1

Project Time schedule of activities

Activities	Year 1				Year 2				Year 3			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Year One												
Consultations with Afghan agricultural researchers, Ministry of Agriculture, NGOs and other potential partners; recruitment of counterpart staff; development detailed work plans.												
Preliminary review of target sites and crops; review of available data.												
Market study												
Ordering and shipment of materials												
Establishment of Protected Agriculture Center (PAC) in Kabul												
Benchmark Study												
Discussions with farming communities and selection of participating farmers												
Establishment of 8 pilot farm sites and start of cultivation												
Preparation and production of training manuals												
Training course on greenhouse installation and preparation for Trainers												
Training course on greenhouse installation and preparation for growers												
Training course on IPPM for Trainers												
Training course on IPPM for growers												
Farmers Field School												
On-the-job training at commercial greenhouse farm outside Afghanistan for 6 Afghan researchers/extension agents												
Training course on IPPM for Trainers												
Training course on IPPM for growers												
Farmers Field School												
End of season workshop for farmers. Analysis of results and outputs.												
Initial rapid assessments to monitor progress against baseline indicators, farmers' perceptions and potential constraints												
Year Two												
Establish 10 additional pilot farm sites												
Training course on greenhouse installation and preparation for Trainers												

Protected Agriculture Project in Afghanistan (RAMP JOB # 9)

Activities	Year 1				Year 2				Year 3			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Training course on greenhouse installation and preparation for growers												
On-the-job training for 6 Afghan researchers/extension agents												
Training course on IPPM for Trainers												
Training course on IPPM for growers												
Mid-Season workshop for farmers and review the problems												
Training course on IPPM for Trainers												
Training course on IPPM for growers												
Farmers Field School												
End of season workshop for farmers; analysis of costs/returns, benefits, etc												
Rapid appraisal to monitor performance indicators and identify potential constraints												
Year Three												
Establish 10 additional pilot farm sites												
Training course on greenhouse installation and preparation for Trainers												
Training course on greenhouse installation and preparation for growers												
Farmers Field School for 10 farmers												
On-the-job training for 6 Afghan researchers/extension agents												
Training course on IPPM for Trainers												
Training course on IPPM for growers												
Mid-Season workshop for farmers and review the problems												
Training course on IPPM for Trainers												
Training course on IPPM for growers												
Farmers Field School												
End of season workshop for farmers; analysis of costs/returns, benefits, etc												
Appraisal of performance and impact												
Recommendations on best practices etc., for expanded development of protected agriculture in Afghanistan												



Annex2

Socio-economic Assessment to Monitor Progress against Baseline Indicators, Farmers Perceptions and Potential Constraints to Wider Adoption of Protected Agriculture (PA) Technology in Afghanistan

Prepared by:

Koffi N. Amegbeto,
Agricultural Economist, ICARDA

25 Sep. – 07 Oct. 2005

1 - Background

Following years of conflict and recurrent drought in Afghanistan, the restoration of agricultural productive capacity is fundamental to the recovery of food security and improvement in the livelihoods of the rural population. The project titled “Introducing Protected Agriculture for Cash Crop Production in Marginal and Water Deficit Areas of Afghanistan” is a component of Rebuilding Agricultural Markets Program (RAMP) that aims to contribute to improving agricultural productivity, market efficiency and rural incomes. It is promoting the adoption of affordable and sustainable protected agricultural systems to produce high value crops, using marginal or otherwise non-productive lands and water more efficiently. The technology offers great flexibility for timing the production of a wide range of vegetables that can generate substantial improvement in yields and farm incomes. The project is being implemented since 2004 to introduce protected agriculture techniques to the farming community in the provinces of Kunduz, Ghazni, Parwan, Nangarhar, Kabul, and Helmand by installing simple greenhouse structures at selected pilot sites with participating farmers, establishing a Protected Agriculture Center (PAC) at the Badam Baugh Research Station for research and problem solving, and within the Ministry of Agriculture & Livestock for demonstration. At the same time it provides training and technical backstopping to project participants and other stakeholders.

2 - Objective of the mission and methodology

The objective of this mission is to monitor project's performance against baseline indicators, conduct a socio-economic assessment of farmers' perceptions of the technology, and identify potential constraints to its wide adoption in Afghanistan. The rapid assessment





mission was conducted by Dr. Amegbeto from 25 September to 07 October 2005. In order to maximize the chances of meeting participating farmers and other stakeholders, the mission took place in conjunction with two training sessions on integrated production and protection management and two farmers' field schools that were organized in Kunduz and in Kabul respectively. These sessions offered the opportunity to conduct a participatory assessment of the technology, to prioritize constraints, and to discuss the advantages and issues emerging from exposure to it. Overall, 60 participants (farmers, technicians, extension and NGO staff) contributed to the group discussions in Kunduz and in Kabul respectively (lists in appendix). Furthermore, separate visits to pilot growers in the provinces were made to collect more specific data on individual performance according to the detailed program of activities shown in the appendix. Because of the limited number of growers who have at least one season for production experience, an attempt was made to systematically sample and interview all of them instead of a random sampling. A total of 17 growers were therefore interviewed. Due to security concerns, the mission was not able to reach Helmand and Nangarhar; however growers from these provinces attended the group discussions. Finally, the mission was provided with progress reports and other documents for reference. The project's program of activities was reviewed with particular attention to its achievements and results are summarized in the following sections.

3. Results and discussions

3.1 Project achievements and performance

The implementation of the project "Introducing Protected Agriculture for Cash Crop Production in Marginal and Water Deficit Areas of Afghanistan" is on course and progressing with great satisfaction. After two years of activities it made the following outstanding and impressive achievements:

- **A protected Agriculture Center is established in Kabul;**
- **Forty one (41) greenhouses installed in the provinces of Kunduz, Ghazni, Parwan, Nangarhar, Kabul, and Helmand;**
- **Seventeen (17) training courses organized on different themes namely: greenhouse manufacturing, preparation and installation; and Integrated Production and Protection Management;**
- **Additional 2 training courses were organized outside of Afghanistan, in Egypt and Oman respectively;**
- **Three (3) workshops organized for policymakers, Ministry technical staff, NGOs and farmers;**
- **Seven Farmers' Field Schools (FFS) organized for practical sessions and experience sharing among current and potential growers in the six provinces;**





- **Eight training manuals on greenhouse installation, climate control, irrigation, requirements for crops, fertigation, management of drip irrigation, nursery for crops, vegetable production were prepared, translated into local languages and distributed to trainees;**
- **Hundreds of beneficiaries including farmers, Ministry staff and NGO personnel were trained;**
- **A market database is being established for seven greenhouse crops: egg plant, tomato, pepper, sweet pepper, cucumber, squash, and green beans.**

Compared to the milestones to be achieved by the end of the second year, the above achievements as summarized in the Table 1 are commendable. The number of operational pilot farm sites has reached 35 representing almost twice (94% increase over) the initial target. A total of 17 training courses on greenhouse manufacturing, preparation and installation, integrated production and protection management were completed. The target number of training course is achieved and complemented by a doubling of the number of training manuals. These benefited hundreds farmers, Ministry staff and NGO personnel and have had serious effects on the perception of greenhouse technology that is drawing substantial interest within farming communities in the provinces. Consequently, potential growers are subscribing to access the technology and use it for vegetable production.

Table 1: Project performance indicators

Description	Target milestone (by year 2)	Performance indicator /status as of 02 October 05	Observed gap from target
Protected Agriculture Center	1	1	Completed as planned in first year
Pilot farm greenhouses	18	35 established among which 12 are in their second or third production season	94% increase beyond target
Training courses	14 (7 per year)	17	21% above target
Farmers Field School	4 (two each/year)	7	75% increase above target
Number of trainees	152	380	150% increase, 2.5 times the target; this may carry the risk of less effective effect if trainee number per session is high.
Market database for greenhouse crops	1	1	On course for egg plant, tomato, pepper, sweet pepper, cucumber, squash, and green beans collected in Kabul VGM
Training manuals	4 (by project end in 06)	8	Twice the target set for project end. Impressive result achieved for the following themes: greenhouse installation, climate control, irrigation, requirements for crops, fertigation, management of drip irrigation, nursery for crops, vegetable production.





3.2 Perceptions of the greenhouse technology

3.2.1 Perceived advantages

The initial assessment focused on the relative advantage of greenhouse technology compared to open field crop production, its comparability and complexity, and observability of its outcomes. Participants were somehow split regarding what is perceived as the single most important or positive advantage derived from greenhouses. According to a subgroup, yield is the most positive advantage while participants in the other subgroup think it is the income. This sort of split could be expected because growers have had production experience in different seasons and did not receive the same prices for their produces. However, all participants agreed that protected agriculture technology is simple and therefore not too demanding compared to open field production; its advantages are clearly observable and convincing. About 89% of participants asserted that it is far better than open field production of vegetable. The following advantages were enumerated within the group:

1. It requires less labor for a much higher production;
2. Can produce high yield on limited land area, as much harvest on 270 m² as on 1 jerib and in some places 2 jeribs of open field production;
3. Easy distribution of fertilizer to plants in the drip fertigation system and less likeliness of wasting;
4. There is less incidence of pest and diseases; their control is easier when they occur in the greenhouse;
5. The greenhouse requires less water, fertilizer, chemicals, labor, no tractor service is needed for land preparation;
6. Better quality of cucumbers that attracts higher price compared to those harvested on open fields;
7. The greenhouse offers the possibility to produce vegetables in winter when prices are high;
8. It offers the opportunity to women to work even though that has not happened yet with current growers;
9. It is a good and appropriate technology to be used on marginal land;
10. Appropriate technology for some landless farmers having no land or only 1 to 2 jeribs;
11. As much or even better monetary returns compared to poppy production; according to another participant who intervened in the same line of thought, he obtained in 1 greenhouse income he used to get on 5 jeribs growing crops in open field.





All the technical and economic advantages of protected agriculture have been fully identified by participants in the group discussions. This provides evidence that some growers are actually getting the benefits this technology is intended for or the farmer field schools and trainings courses conducted so far have been very effective.

3.2.2 Perceived constraints

Despite a good appreciation of the greenhouse technology and farmers' eagerness to try it, there are few constraints that were identified during the group discussions. Some of these constraints prevent accessibility, trial and adoption or rejection while others are related to difficulties encountered by pilot growers. The following constraints were enumerated by participants:

1. Timely distribution of seed for planting;
2. Inappropriate timing of planting to meet high market price, especially in winter
3. Greenhouse is a high investment technology which most Afghan farmers cannot afford on their own;
4. Non availability of specialized inputs (fertilizer, hybrid seeds, construction material) in local markets;
5. Lack of electricity in rural areas, lack of cooling as well as heating equipments that would permit vegetable production in summer and winter respectively in highland /lowland agricultural systems having extreme temperatures;
6. Insufficient technical backstopping;
7. Inadequate grasp of the techniques used for controlling temperature and humidity as well as pests or diseases in the greenhouse.

In terms of constraint prioritization, Kabul, Parwan and Ghazni growers were asked in group discussions to rank each constraint according to its severity on a scale from 5 (extremely severe constraint) to 3 (moderately severe), 1 (not so severe) and 0 (not a constraint at all). The following Table 2 summarizes the results. Among the constraints identified by growers and other participants, the lack of hybrid seed and specialized fertilizer formulations on local markets, inadequacy of technical backstopping, lack of money to invest or credit scheme to ease the financial burden were ranked by 89 to 100% of participants as severe constraints to a wide uptake. In addition, non-availability of construction materials especially the plastic sheet, was ranked as an extremely severe constraint by 22% of participants, and not a severe constraint to the uptake of protected agriculture by 44% of them. Three additional





constraints were identified by pilot growers: controlling the temperature, humidity, and pest or diseases inside the plastic houses were ranked as extremely severe (56% of growers) or moderately severe constraints (44%). Soil preparation is a moderate constraint for 22% of growers. These results indicate areas where technical backstopping should emphasize.

Table 2: Distribution of growers according to perceived constraints

Constraint	Scale				Total
	5	3	1	0	
<u>To adoption</u>	Percent				
Availability of construction materials	22		44	33	100
Lack of money /credit to invest	100				100
Technical backstopping	89	11			100
Availability of hybrid seed	100				100
Availability of special fertilizers	100				100
<u>In use</u>	Percent				
Soil preparation		22		78	100
Sowing techniques				100	100
Fertigation /irrigation			100		100
Ventilation				100	100
Training and pruning of plants				100	100
Controlling temperature and humidity	56	44			100
Pest and disease control	56	44			100

In view of the constraints identified, there is a need for continued and more frequent visits for technical support to the pilot growers who are currently experiencing this technology. Their success will determines the future of the technology and the extent to which it could contribute to the ultimate goals of increased productivity, food security, and improved livelihoods in each community with spillover effects that have positive impacts on the Afghan economy as a whole. In our views they should not be left alone for more than a week without the visit of the project technicians in charge of the respective provinces.

Farmers and other people who have been exposed to the greenhouse technology showed a lot of enthusiasm for trying and adopting it. Most of them would like to own at least one structure; however the preferred number stated is up to 10 greenhouses or “as many as they can fit on their land” as one farmer puts it. It is worth mentioning that those who expressed their willingness to uptake the technology also specified the need for some financial supports or at least a credit scheme to fund the venture. From participants’ perspectives, options for expanding access and adoption of greenhouses are the provision of financial support, increased in technical backstopping, hand-on application and training





particularly through the formation of, or support to, growers' association that could demonstrate the technology and train other farmers. There was at least one call during the group discussions for the introduction of protected agriculture technology to other provinces especially Baghlan.

3.3 Growers' performance from technical and economic perspectives

3.3.1 Productions and incomes from greenhouses

All growers participating in the project have been selected by the project team according to specific criteria namely, interest and willingness to try the technology, availability and access to good quality water, availability of land space to host the structure, acceptance to follow recommendations from the project, etc. Since these pilot growers were purposely selected, a description of their socio-demographic characteristics is omitted in this report.

In order to assess cucumber growers' performance during the March-August 2005 season, each one was examined as a case study to determine the income generated, and the technical and economic resource use efficiency. The number of cucumber produced during the first season of 2005 under greenhouses varies from 4,000 to 26000 fruits (Table 3). Many growers received a price premium for the quality of cucumber produced under greenhouses. Prices received by farmers were as low as Afs 2 /fruit and up to Afs 4.5 per fruit; yet most growers were on the lower side of the price range. According to them, the Afghan consumers prefer bigger and long cucumber fruit as opposed to the type they grow. Therefore, it would be necessary to introduce to growers other varieties that fit such preferences.

Protected agriculture is very promising with respect to the use of marginal land, labor and water, and has effectively made positive impacts on the income generation capacity of many growers. There is substantial evidence that the technology is economically viable in the context of Afghanistan. For example, cucumber production in the past spring season generated additional farm income of Afs 13,200 to 78,000 per grower, and net income (above total production costs) ranging from a moderate loss into positive territory that is as high as Afs 35,500. Therefore, success levels vary among growers. For example, Mr. Mula Dad is a 28 years old grower from Parwan province who has so far made the highest income from greenhouse production of cucumber in Afghanistan during the March-August 2005 season. He used to work with his father within an extended family, and his father was financially responsible for all members. A couple of years ago his father decided to share his land among him and three other brothers. He received 1 jerib of land and cultivated wheat and turnip in rotation before his exposure to the greenhouse technology. Married with 2 children, Mr. Mula Dad has been working as a labourer in the construction sector; his income was not





only volatile but also very low (about Afs 2,000 per month). During his first season, he produced about 26,000 cucumbers from his 270m² greenhouse and sold them at Afs 3 per cucumber on average. He remembers that he earned at least Afs 60,000 cash from this activity (some cucumbers were given to friends and visitors) which he spent on his family and has a small saving. Now the power centre in the extended family shifted onto him because of improvement in his financial status. He declared that if he had money he will invest it in the greenhouse and he is ready to fit as many greenhouses as possible on his land. It is worth mentioning that Mr. Mula Dad participated in numerous training courses (in Afghanistan and Cairo) and farmers field schools organized by the project.

In other instances, results are not as good as one would expect because greenhouse is a new technology that is being tried over just 2 years. For example, one grower is in his third season and has harvested 1000 cucumbers in the first season and 4000 in each of the other two seasons. He has earned this year about Afs 26,400 from cucumber production as supplemental income to his annual salary as a school teacher. Unfortunately, his plants are completely devastated by a sudden wilt and there is limited hope they will recover.

Table 3: Production and income from greenhouse activities

Province	Name of grower or location	Production	Unit price	Income	Return to labor ¹	Resource use efficiency	
		No fruits	Afs	Afs	Afs /Manday	kg /m ² (²)	kg /m ³ (³)
Kunduz	Mohamad	16000	4.0	64000	1000	7.4	11
Kunduz	Ali Abad	7652	2.4	18365	287	3.5	5
Helmand	Rassouli	16000	2.0	32000	500	7.4	11
Helmand-Garashk	Mohamed Qasim	12400	2.1	26040	407	5.7	9
Parwan	Mula Dad	26000	3.0	78000	1219	12.0	18
Ghazni Qalamiri	Hadj Mohamad Arif	10550	4.0	42200	659	4.9	7
Ghazni Khaja Omari	Haji Abdul Salam	10000	4.5	45000	703	4.6	7
Kabul	Mir Abdel Samir	10000	2.2	22000	344	4.6	7
Kabul-Bagrami	Mahmoud Shad	6000	2.4	14400	225	2.8	4
Kabul-Chara Asib	Mohamad Yusouf	4000	3.3	13200	206	1.9	3
Nangarhar	Abdul Ahad	9970	2.2	21934	343	4.6	7
Nangarhar	Zarif	9060	2.0	18120	283	4.2	6
Average		11469	2.8	32772	512	5.3	8

Source: information collected from growers

1. Based on revenues and out-of-pockets expenses of each grower on material inputs.

2. On average 8 cucumbers from the variety grown weigh 1 kg.

3. Based on an estimated 180 m³ water use during the season per greenhouse.

Compared to current achievements by growers, the production potentials for cucumber and other vegetables using greenhouses are enormous and need to be tapped. Overall, the



economic performance of growers is expected to improve when inputs become available and cheaper on local markets compared to current imports, and production techniques acquired over time.

3.3.2 Sensitivity analysis of minimum yield to achieve break-even

To be successful, adopters of the greenhouse technology must plan and manage in a way that produce's price covers at least the unit production cost. Based on current production costs inside 270m² greenhouse and because growers are price takers or cannot individually influence market prices, a sensitivity analysis was conducted to indicate the minimum yield required at a given market price to cover production costs. The result shows that cucumber growers should target yields above 24,000 fruits for summer sales when prices could be as low as Afs 1.5/fruit. Contrarily, yield should be above 8,000 fruits when the price is expected to be higher than Afs 5/fruit for sales in winter or during Ramadan (Figure 1 below). Beyond these threshold yields and at specified price levels, they move into the profitable territory and generate positive net incomes.

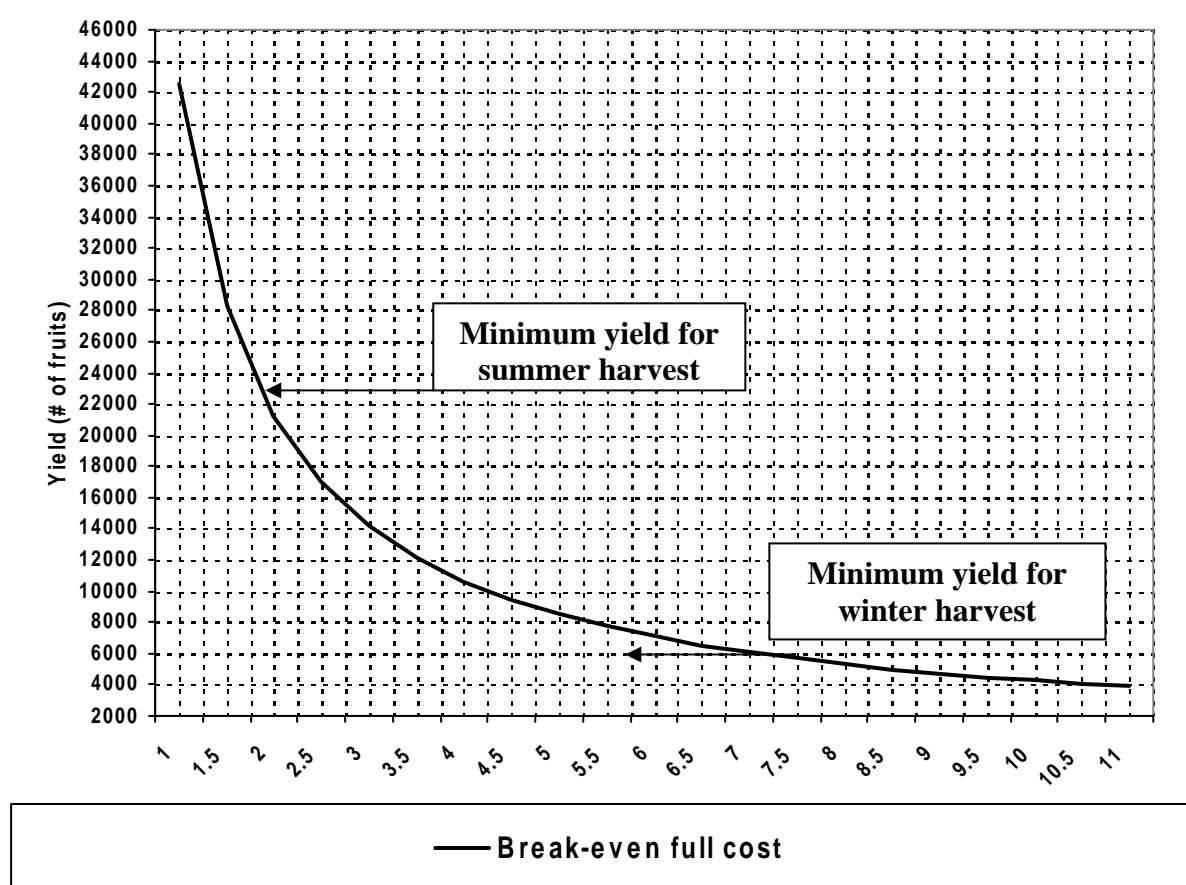


Figure 1: Minimum yield for given prices to break-even in cucumber production under greenhouse



3.3.3 Comparison of cucumber production in open field and greenhouse

Based on current greenhouse investment and crop production costs the profitability as well as water, land, and labor use efficiency parameters were estimated for comparison between open field and greenhouse productions on one jerib of land. In consideration of adequate spacing and ventilation, it is projected that 6 greenhouse structures could fit on 1 jerib of land. It is assumed that open field cultivation uses at least 10 times the volume of water required under greenhouse production. Results in Table 4 show the superiority of greenhouse technology for cucumber production to the alternative, even though it requires some investment and high working capital. Total income generated under greenhouse is 6 times higher and the net income 4 times higher than what is obtained in open field per jerib of land. This is a tremendous advantage given that greenhouses can be installed on marginal lands with very low rental value in rural areas. Compared to arable land rent charge of Afs 800 per jerib (normally paid in kind: 70 kg for one jerib) charged in some communities in Ghazni for example, greenhouse represents an excellent opportunity for income generation of farmers. Similarly, the return to labor is 69% higher under greenhouse cultivation with a substantial water saving.

Table 4: Comparison of profitability of cucumber production under greenhouse and in open field (1 jerib)

Item description	Unit	Greenhouse (GH) Production ¹	Open field (OF) Production	Net change GH over OF (%)
Production ²	kg	19,500	3,700	427
Producer price ³	Afs /kg	24	18	33
Material input cost	Afs	118,200	4,650	2,442
Labour costs	Afs	76,800	18,000	184
Depreciation /season	Afs	60,000	-	
Total production cost	Afs	255,000	22,650	913
Total income	Afs	468,000	66,600	603
Net income /return to land	Afs	213,000	43,950	443
Yield per unit of land	MT /Jerib	20	3.7	427
Water efficiency⁴	kg /m ³	18	2.1	778
Net return to labour & management	Afs /manday	1,166	688	69
Net return per unit of water	Afs / m ³	221	24	805

Data source: information obtained on spring production of cucumbers from the grower in Parwan.

5. For adequate spacing and ventilation 6 greenhouses could fit on 1 jerib of land.
6. Open field cucumbers are longer and bigger than those being produced in greenhouses due to variety difference; accordingly 6 open field cucumbers weigh 1 Kg while 8 greenhouse cucumbers weigh 1 Kg.
7. Cucumbers are sold per unit not per kilogram; greenhouse cucumber carries a price premium for quality.
8. Assume open field uses 10 times more water than greenhouse cucumber production.





3.3.4 Impacts of PA technology on growers' income

The impact of the greenhouse technology on growers' incomes was assessed. With only one exception, all growers interviewed have not changed their cropping patterns, the number of crop or the size of land they use to cultivate prior to their induction to protected agriculture. Therefore, for these farmers the greenhouses were add-ons to the portfolio of crops they used to grow and incomes. Table 5 presents the growers' names with areas cultivated for each crop, estimated total income from these crops, and that obtained from the greenhouse activity. The last column shows the percentage change in farmers' income and other observations regarding land ownership, their willingness to adopt this technology. The level of income varies tremendously among the pilot growers, from as little as Afs 32,000 to Afs 2,750,000 per year. As such the basis for assessing PA contribution is not the same. Results show that greenhouse structure contributed between 8% and 138% increase in income generated from crop production so far in 2005. This has somehow catalyzed the interest of these farmers who expressed their willingness to accept more structures anytime from now.

4 – Conclusion

The PA project has achieved impressive results compared to the milestones set for the end of the second year. The efforts invested in its implementation are paying off as many potential growers are attracted to the greenhouse technology and are willing to adopt or at least try it. Generally, growers' performance with protected agriculture is mixed as one would expect from any new technology; some are picking up quickly and easily the techniques, doing well whereas others are not. There are indications that the advantages of PA technology are being felt in the six provinces and beyond in terms of labor, land and water use efficiency as well as income generation. Farmers and other stakeholders have generally a good perception of the PA technology amid some constraints such as controlling the temperature, humidity, pest or diseases, and soil preparation before planting. Similarly, the issue of credit or financial support towards acquiring the greenhouse structure, availability of construction materials and specialized inputs are extremely important and should be addressed to achieve a wide adoption of the technology. There is a need for continued and more frequent visit for technical support to pilot growers who are currently experiencing this technology. Accordingly, growers should not be left alone for more than a week without at least one visit. Their success will determines the future of the technology and the extent to which it could contribute to the ultimate goals of increased productivity, food security, and improved livelihoods in each community with spillover effects that have positive impacts on the Afghan economy as a whole.





Table 5: Assessment of greenhouse contributions to growers' incomes in Afghanistan

#	Grower (province)	Baseline crop portfolio of grower and area (jeribs)	Estimated total income for grower (Afs)	Income from GH activity in 2005 (Afs)	Observations
1	Said Mahboob (KDZ)	Wheat (58) Cotton (12) Mung bean (16) Rice (42) Tomato (1)	390,643	New cucumber grower; no harvest completed so far	Crops are grown in rotation with wheat. Production in extended family with 6 other brothers.
2	Mohamad (KDZ)	Wheat (8) Rice (8) Melon (2) Sesame (2)	272,800	Afs 64,000 from first season	Second time cucumber grower, one harvest completed with 24% increase in annual income; second season harvest started and is being sold for afs 4 per cucumber (end Sept 05). He owns only 5 jeribs of land.
3	Mahmoud Shad (KBL)	Wheat (2), Apricot nursery (0.5) Potato (0.4) Alfalfa /fodder (1) Tomato (0.1) pepper (0.75)	170,700	Afs 14,400 from first season.	Second time cucumber grower with 8.4% increase in annual income. He owns only 5 jeribs of land
4	Rassouli (HMD)	Wheat (8), egg plant (4), okra (4)	284,000	Afs 32,000 from first season	Second time cucumber grower, one harvest completed with 11.3% increase in annual income. Would like to have 3 additional greenhouses
5	Mula Dad (PWN)	Wheat (1), turnip (1)	32,700	Afs 78,000 from first season .	Second time grower, he experienced 138% increase in his annual income in one growing season. He owns only 1 jerib of land and works also as construction laborer. He is willing to take as many GH as he can fit on his land.
6	Mir Abdul Samir (KBL)	Wheat (2), tomato (2) grown in rotation with wheat, apricot (4)	328,000	Afs 22,000 from second season.	First pilot producer who started in Afghanistan. Third time grower of tomato, cucumber and tomato respectively. From the second season he obtained 6% increase in annual income. He owns 15 jeribs but most of the land is rocky, mountainous and not suitable for cultivation
7	Mahmadu yusouf (KBL)		60,000	Afs 13,200 from first season	Second season of cucumber production in greenhouse. Obtained 22% increase in annual income. His main occupation as teaching.
8	Nazar Mahmad (GNI)	Wheat (8), grapes (30)	2,752,000	No harvest completed so far	First season grower having a small greenhouse of 156 m ²
9	Hadj Mohamad Arif (GNI)	Potato (2), tomato (2.5), grapes (5), peach /plums (6)	240,000	Afs 42,200 from first season	Second season cucumber grower with 18% increase in annual income obtained from a single season. He owns 15 jeribs.



Table 5 cont.

#	Farmer (province)	Baseline crop portfolio and area (jeribs)	Estimated total income for grower (Afs)	Income from GH activity in 2005 (Afs)	Observations
10	Haji Abdul Salam (GNI)	Wheat (40), potato (6) barley6, tomato (0.25), onion (2), apple (8)	260,929	Afs 45,000	Second season cucumber grower in 270 m ² greenhouse. He obtained 17% increase in annual income from just one season. Produces other crops within an extended family with 6 other brothers; he used to supplement his income as part-time trader.
11	Mohamad Dahood (GNI)	Wheat (10), potato (6), barley (8), tomato (1.5), cucumber (2), apricot (4) but not productive yet	528,000	No harvest completed so far	First time cucumber grower having a 270 m ² greenhouse.
12	Ghulam Rahani (GNI)	Wheat5 Potato (3), tomato (1)	101,250 his share	No harvest completed so far	New grower having a small 174 m ² greenhouse. He shares 8 jeribs for crop production with his brother.
13	Mirajidin (KDZ)	Fruit plantation (50 ha)	Not declared	No harvest completed so far	First time grower and would like to get 4 to 6 additional GH if he has money
14	Aga Ghol (HMD)	Not available	Not declared	54,000 from first season	Second time cucumber grower. This technology provides income higher than some alternative cash crops he said.
15	Shah Mohamad (PWN)	Wheat (8)	40,000	No harvest completed so far	First time grower, he harvested 2000 cucumbers this season which he sold at Afs 6 per fruit. This partial harvest generated 30% of what he used to have as annual income. He is strategically delaying this week's harvest in order to sell in Ramadan time (in a couple of days) when the price is higher. He said he is willing to take 10 additional greenhouse structures.
16	Abdul Ahad (NGR)	Not available	Not available	Afs 21,934 from one season	Second time grower having a 270m ² greenhouse.
17	Zarif (NGR)	Not available	Not available	18,120 from one season	Second time grower having a 270m ² greenhouse.

APPENDIX**Program of activities**

Sun 25 Sep.	Travel from Aleppo to Dubai
Mon 26 Sep.	Travel from Dubai to Kabul Discussion with Dr. Wassimi and other colleagues. Travel from Kabul to Kunduz (by road).
Tues 27 Sep.	Farmer field school in Kunduz; discussion with pilot farmers; Group discussion with participants to document their perceptions of the PA technology.
Wed 28 Sep.	Meeting with a pilot grower in Kunduz and Parman Travel to Kabul
Thu 29 Sep. Ministry of province)	Visit to Bagh Dambagh Research station, PA Center in the Agriculture, and growers in Kabul and Chara-Asib (Kabul
Fri 30 Sep. to go security	Visit to Mr. Mahmoud Shad in Bagrami, Kabul province. Attempt to Chara-Asib was aborted due to heavy traffic congestion and Concerns.
Sat 01 Oct.	Farmers' field school followed by group discussions in Kabul
Sun 02 Oct.	Visit and discussion with growers in Ghazni
Mon 03 Oct.	Travel from Kabul to Dubai
Tues 4 -Thu 6 Oct	Briefing the Project PI (APRP Coordinator); Data analysis & preliminary report.
Fri 07 Oct.	Travel from Dubai to Aleppo.

List of participants in FFS of 1/10/2005 in Gul Bagh Kabul Province

No	Name	District	Province
1	Haji Abdul Salam	Khoja Omari	Ghazni
2	Mohammad Isahaq	Qala Miri	Ghazni
3	Mula Dad	Tutumdara	Parwan
4	Abdul Qaher	Bagram	Parwan
5	Alahlh Bubani	Tutumdara	Parwan
6	Malik Jan	Kariz Mir	Kabul
7	Nader Khan	Kariz Mir	Kabul
8	Mohammad Yousf	Char Asiab	Kabul
9	Mir Abdul Sami	Gul Bagh	Kabul

List of participants in group discussions

#	Name	Designation	Province	Location
1	Mirajudddin Arab	Farmer	Kunduz	Chardarah
2	Hayatullah Haydar	Farmer	Kunduz	Imamsahib
3	Guldin	Farmer	Kunduz	Aliabad
4	Mohammad Alim	Farmer	Kunduz	Center
5	Bashir Ahmad Ibrahimi	Farmer	Kunduz	Aliabad
6	Sayed Mahboob Hashimi	Farmer	Kunduz	Chardarah
7	Tahir	Farmer	Nangharhar	Khoqyani
8	Malik Masjedi	Farmer	Nangharhar	Surkha rood
9	Mohammad Yaseen	Farmer	Nangharhar	Surkha rood
10	Fazil Haq	Farmer	Nangharhar	Center
11	Haji Jan Mohammad	Farmer	Ghazni	Qarabagh
12	Ghulam Rohani	Farmer	Ghazni	Center
13	Mohammad Dawood	Farmer	Ghazni	Center
14	Nazar Mohammad	Farmer	Ghazni	Center
15	Mohammad Azam	Farmer	Helmand	Laskharga
16	Mohammad Qasem	Farmer	Helmand	Greshk
17	Juma Gul Balol	Farmer	Helmand	Laskharga
18	Haji Mohammad Sanam	Farmer	Helmand	Center
19	Ezatullah	Farmer	Helmand	Center
20	Agha Gul	Farmer	Helmand	Bolan
21	Shad Mohammad Shad	Farmer	Parwan	Bagram

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22	Enayatullah	Farmer	Parwan	Tutum Dara
23	Khan Mula	Farmer	Parwan	Charkar
24	Ghulam Farooq	Farmer	Parwan	Jabul Saraj
25	Dost Mohammad Sediqi	Research Director MAAHF	Kunduz	Center
26	Mir Afzal Sadat	Technician	Parwan	Charkar
27	Hidiyatullah Kakar	Technician	Kunduz	Imamsahib
28	M.Sarwar Akbari	Technician	Kunduz	Center
29	Jalaluddin Hamed	Technician	Kunduz	Center
30	Haji Habib Rahman	VBSE Assistant	Takhar	Talouqan
31	Noor Hazrat Anoor	VBSE Assistant	Kunduz	Center
32	Sofi Zainullah	VBSE Assistant	Kunduz	Khanabad
33	Ali Madad	Agriculture Business Management Mercy corps	Kunduz	Center
34	Khairullah	Agriculture Dept Extension Director , MAAHF	Baghlan	Fabrika
35	Abdul Qayoum Shahibzada	Agriculture Research Director MAAHF	Takhar	Talouqan
36	Abdul Ahad Ahad	Agriculturist Mercy corps	Kunduz	Center
37	Sultan Mohammad	Agriculturist Mercy corps	Kunduz	Center
38	Mohammad Zahir	Agriculturist Mercy corps	Takhar	Talouqan
39	Mohammad Ayoub	Coordinator Central zone	Ghazni	City
40	Khalid Wadan	Coordinator eastern zone	Nangharhar	Jalal Abad
41	Wazir Gul Rasouli	Coordinator S.W Zone	Helmand	Laskhargha
42	Shah Mohammad Mohaqiq	Coordinator N.E Zone Afg	Kunduz	Center
43	Jan Agha Totakhil	Enterprise section Mercy corps	Kunduz	Center
44	Mohammad Ayoub Bajawri	Enterprise section Mercy corps	Kunduz	Center
45	Ahammad Shah	Enterprise section Mercy corps	Kunduz	Center
46	Ramazani Maqsood	Extension Director MAAHF	Kunduz	Center
47	Hafizullah Qaloq	Extension worker MAAHF	Kunduz	Archie
48	Ghulam Ali sharifi	Extension worker MAAHF	Kunduz	Chardarah
49	Abdul Basir Faqiry	Extension worker MAAHF	Kunduz	Khanabad
50	Mohram Ali Samadi	Extension worker, MAAHF	Kunduz	Aliabad
51	Gul Mohammad	Farmer VBSE member	Kunduz	Chardarah

Annex 3

Vegetable Price Analysis and Marketing Windows for Protected Agriculture Technology Adopters in Afghanistan

Prepared by:

Koffi N. Amegbeto
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February 2006

Abstract

This study examined the dynamics of selected vegetable prices and quantities supplied to the main fruit and vegetable market in Kabul, Afghanistan. It aimed to determine the appropriate timing of production under Protected Agriculture or greenhouse conditions that would allow producers to take advantage of supply deficiencies and maximize returns when prices are high. In addition, price forecasting models were developed to aid in vegetable marketing decisions using data collected from market commissioners that purchased and auctioned vegetables between August 2004 and December 2005. Results show that prices and supplies of cucumber, egg plant, green beans, pepper, squash, sweet pepper, and tomato were erratic and negatively correlated in most cases. Vegetables were mainly supplied to Kabul market from Pakistan between November and April, which generally corresponds to low supplies and high prices. Spring season production of vegetable in Afghanistan that is harvested in the summer (May, June and July) coincides with supplies from Pakistan and therefore, market demand is shared among the two sources. Summer productions of vegetable that are harvested and marketed in August, September, and to some extents in October tend to crowd Pakistan traders out of the local market. Unfortunately, prices are relatively low in those months.

The implication for the Afghan vegetable growers who adopted Protected Agriculture technology is that there may be an opportunity to compete and increase market share for vegetables by extending harvests into November and part of December. Alternatively, an early spring planting strategy (in late February through March) when the cold temperature does not reach extreme levels, could be adopted in order to harvest in May. Both strategies require an increase in efficiency of operations that minimizes production costs and confers to the local grower a competitive advantage over Pakistan rivals. If however, these growers can adequately equip and manage their greenhouses with a heating system, then most vegetables could be planted for timely harvest and marketing between November and April coinciding with high prices.

A comparison of price forecasting models developed for cucumber and tomato provide evidence of the necessity to continuously update market information on prices in order to project more accurate future price forecasts. These models predicted very well out-of-sample price forecasts and therefore, could be used by marketing extension agents as well as project staff to help vegetable growers improve their production and marketing decisions. Further analysis will evaluate alternative crop rotation schemes to maximize growers returns over time based on unit production costs, gross margins, and elements of risks associated with vegetable production in Afghanistan.

1. Introduction

A wide range of vegetable crops can be grown in the diverse agro-ecological zones of Afghanistan. Melon, watermelon, onion, potato and tomato are the predominant crops being cultivated on 87% of the total area under vegetable cultivation according to a survey conducted by the FAO in 2000.¹ Vegetable production could be extended on a large scale to other crops such as cucumber, pepper, green beans, squash, etc. all year round if they are grown using the greenhouse technology commonly known as Protected Agriculture. It is a system of integrated production under plastic house environment that includes fertilization, irrigation, heating, cooling, ventilation management as well as crop protection management practices against insects, other pests and diseases. The technology offers great flexibility for timing the production of a wide range of vegetables that can generate substantial improvement in yields and farm incomes while contributing to a sustainable management of water and land resources. Yet, it requires a clever decision making in order to benefit effectively from markets highs. Because vegetables are highly perishable and nearly no stocks are carried over a long time to smooth out market supplies, their prices vary substantially across different periods of the year. In Afghanistan where the climate is not suitable for year round production and technologies that could make it possible are not widely adopted, there are frequent disruptions in local supplies that bid up prices. Currently, much of the supply gap is being filled by traders from neighboring countries. The PA technology provides an opportunity for its adopters to take advantage of the production and supply fluctuations by selling produce when prices are relatively high. It is presumed that a combination of high productivity (yield) and low production cost beside the initial investment in the green house could give Afghan growers a comparative advantage to compete effectively in supplying vegetables to Kabul and other markets in Afghanistan during some periods of the year. Since 2004 a project titled “Introducing Protected Agriculture for Cash Crop Production in Marginal and Water Deficit Areas of Afghanistan” has been promoting the adoption of affordable and sustainable protected agricultural systems to produce high value crops, using marginal or otherwise non-productive lands and water more efficiently. The project has drawn tremendous interest from farmers who do not track vegetable supply and prices systematically towards planning and management of production and marketing activities.

This study was designed to examine the dynamics of selected vegetable prices and quantities supplied, and to determine the timing of production under green house conditions that would allow producers to take advantage of supply deficiencies and maximize returns when prices are high. The approach is based on two distinct presumptions. First, each vegetable grower’s operation is assumed very small compared to market size and therefore, cannot influence prices; as such, the grower is a price taker in the produce market and can base production-marketing decisions on a careful assessment or forecast of what market prices will be. Secondly, vegetable production costs are assumed constant regardless of the season of the year and only the produce price level determines the relative size of profits that could be derived. Results of this study will be used by marketing extension agents and project staff to advice growers who have adopted the greenhouse technology towards improving their production, harvesting, and marketing decisions. Eventually, this will contribute to increased returns on the investment in the green house and generate high and stable income to the farmers. Ultimately, these will improve household food security and livelihoods in rural communities.

¹ Food Security through Sustainable Crop Production in Afghanistan- Technical Report, Food and Agricultural Organization of the United Nations, 2000

2. Materials and Methods

2.1 Market site identification

Given resources that were available in the project the city of Kabul which the largest urban center in Afghanistan was retained for the study. A rapid appraisal was conducted in the Kabul main vegetable and fruit market (VFM) as well as other smaller markets in Shahr-e-now, Mokruan, Pol-e-Kheshti, and Kot-e-sangi located in different sections of the city early 2004 in order to decide about which market to select for the study and data collection. This appraisal found that vegetable prices were mostly the same across the locations except in the Shahr-e-now area that is close to foreign embassies and inhabited by wealthy people. Accordingly, most vegetable retailers in this market normally sort their produces into different quality characteristics as a means to derive some extra sales values. All retailers interviewed in these smaller markets mentioned they regularly make provision of products for sales from wholesalers and commissioners in the main fruit and vegetable market. Therefore, the appraisal went further to focus specifically on this main market in order to get a deeper understanding of its basic organizational structure and mapping (Nejatian, 2004).

2.2 Description of the Kabul vegetable and fruit market

Traders in the main vegetable and fruit market of Kabul are highly organized and led by a market board that includes a president, a secretary and few advisors. The market board has nominated eight main commissioners who make daily auctions to sell the vegetables to wholesalers and some of the big retailers. These auctions start early in the morning as soon as the market opens, and the vegetables dispatched thereafter to different small market places in the Kabul city. It is expected that growers using green houses will form a producer-marketing association that will market their produces as a group for wholesales and could have direct business dealings through the market commissioners. Nearly 200 wholesalers and retailers are active in the market and organized into a corporative. Besides holding the responsibility for managing and maintaining the market areas, the trader cooperative's main task is to participate in the price setting activities of the Price Control and Marketing Department of Kabul Municipality. The latter one monitors markets through different trader cooperatives and provide reference retail prices for some main food items including fruits and vegetables; these prices are announced every two weeks (Nejatian, 2005).

2.3 Data collection and analysis

A one page form was designed and used for data collection. Initially, this form was tested for a couple of weeks to get the enumerator acquainted to the task and make sure the form would be filled properly during the course of the study. Meetings were also held with the head of traders' cooperative and commissioners to explain the purpose of the exercise and finalize arrangements for data collection. Once the process was launched the enumerator visits systematically all eight commissioners every day and gathers information as soon as trading starts. The information collected includes the source of the vegetable, the buying and selling prices (of the commissioners) and the quantity of each produce handled daily by all commissioners. Buying price indicates the average price at which commissioners bought the produce from producer groups or traders, and selling prices indicate the price which these commissioners auctioned the produce to local wholesalers and retailers. The quantity represents new supplies to the market and does not account for stock carry-overs from day to day or produce accumulation in the market at the wholesaler or retailer levels. Data was collected on the above variables between August 2004 and December 2005 on cucumber, egg plant, green beans, pepper, squash, sweet pepper, and tomato, which could be produced in greenhouses. The numbers of monthly data observations, monthly and daily volume of vegetable handled as well as average daily prices for the respective crops are summarized in Table 5-8 in Appendix. Ideally, price figures should be adjusted to account for monthly changes in the rate of inflation and therefore measured in constant term. However, given the paucity of inflation data in Afghanistan, the following analysis is based solely on nominal price levels. Discussions on the dynamic of prices over time are focused on the buying prices market commissioners were paying to their suppliers. The rationale for using this variable is that it is that price vegetable growers could expect to receive from commissioners through their marketing association.

A simple model of inverse demand function was estimated to determine the relationship between vegetable price and the quantity for cucumber and tomato, which are the two crops currently grown by pilot farmers involved in the project. The price series were modeled as a function of quantity including

lag dependent and independent terms. First each price series was tested for stationarity using the Augmented Dickey Fuller test; the length of the lag dependent and independent variables in each equation was identified using the Akaike Information Criteria (AIC) as suggested by Granger and Newbold (1986). Secondly, the estimated models were tested for the presence of autocorrelation and heteroscedasticity of the error terms using respectively the Durbin Watson h-test, the Box-Pierce Q statistics, and the Lagrange Multiplier (LM) test (Greene, 1993). Where the presence of autocorrelated and/or heteroscedastic error terms were confirmed, the appropriate moving average MA(q) was determined based on the AIC parameter and/or weighted least square regressions were estimated. The resulting models were used to generate a myopic and information adjusted price forecasts based on supply that realized in the market beyond the sample period covered by this study. The regression analyses were conducted using Limdep 7.0 software (Greene, 1998).

3. Results and discussions

The following sub-sections present the results on supply amounts and their sources over the period studied, the dynamics of prices at which market commissioner were buying the supplies, and given the average quarterly price levels, the timing and opportunities for greenhouse production in order to harvest and market vegetables when prices are high. The latter represent marketing windows for increasing returns and profitability of greenhouse production systems. The following sections present for each vegetable crop separately.

3.1 Cucumber

3.1.1 Cucumber supplies and price dynamics

Supply of cucumber to Kabul fruit and vegetable market is shown in Figure 1. It remained very low in the range of 96 to 338 thousand fruits per month between August 2004 and March 2005. It increased from the monthly total of 950 thousand fruits in April 2005 to its maximum (6.7 million fruits) in July before dropping sharply in August. Between September and November 2005 supply levels remained slightly above what it was in the preceding year with a substantial difference in December where it was nearly 10 times higher compared to December 2004. Generally, supply in the last quarter of 2005 was higher than that of the same quarter in 2004.

With respect to supply sources as shown in Figure 2, cucumber came mostly from Pakistan between November 2004 and April 2005, whereas the reverse is observed in August, September and October 2004 and 2005 respectively. During the period of May to July 2005 cucumber supply was shared unevenly between the two sources.

The nominal price at which market commissioners bought cucumbers increased from \$65 per thousand fruits to \$ 114 between August and October 2004. It followed a downward turn thereafter until May 2005 to \$40, remained relatively stable around \$ 42 per thousand fruits (four year average) between May and August 2005. In the last quarter of 2005 the price took an upward trend although a dip was observed in November. Overall, monthly average cucumber prices and quantities supplied to the Kabul market are negatively correlated with a coefficient of -0.48. This negative correlation reflects the market demand behavior and implies that prices declined as supply to the market increased. Market commissioners retained marketing margins on buying and auctioning cucumbers. This margin is proportional to the price and therefore increases (decreases) according to price trends. As such, these margins are lowest in the period from May to August when average auction prices are also at their lowest level.

The vegetative period for cucumber is 40 days before maturity and harvesting period may take up to 120 days. If a transition of 10 to 20 days is allowed between consecutive production cycles, then only two cycles can be carried out within a twelve month period. The appropriate strategy for a cucumber grower in Afghanistan would be to compete with Pakistan suppliers during the months when prices are very or intermediate. Therefore, planting decision must be made such that harvesting corresponds to such a period. Based on quarterly price averages recorded during 2005, cucumber planting could start in the second quarter of the year (June-July) to make sure harvesting and marketing are completed by the end of November or December. Even if heating facilities are available for greenhouse production in winter, the harvest of a subsequent production that starts in January-February will coincide with low market prices mainly between April and June. While it may still be financially appealing to have this second production cycle compared to open field production, it would be better to consider a rotation

crop to replace cucumber in the greenhouse. Such a decision could be based on unit production costs or comparative gross margins, information which is not yet available for all the potential crops.

Figure 1: Cucumber supply and price dynamics in Kabul, Afghanistan

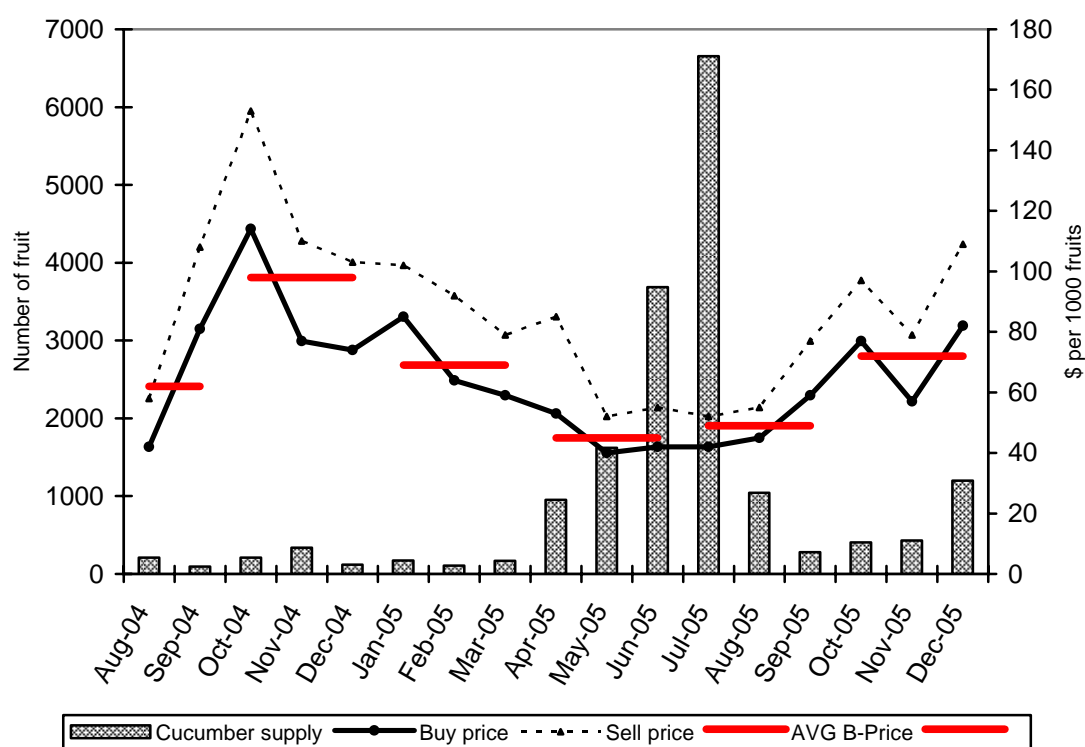
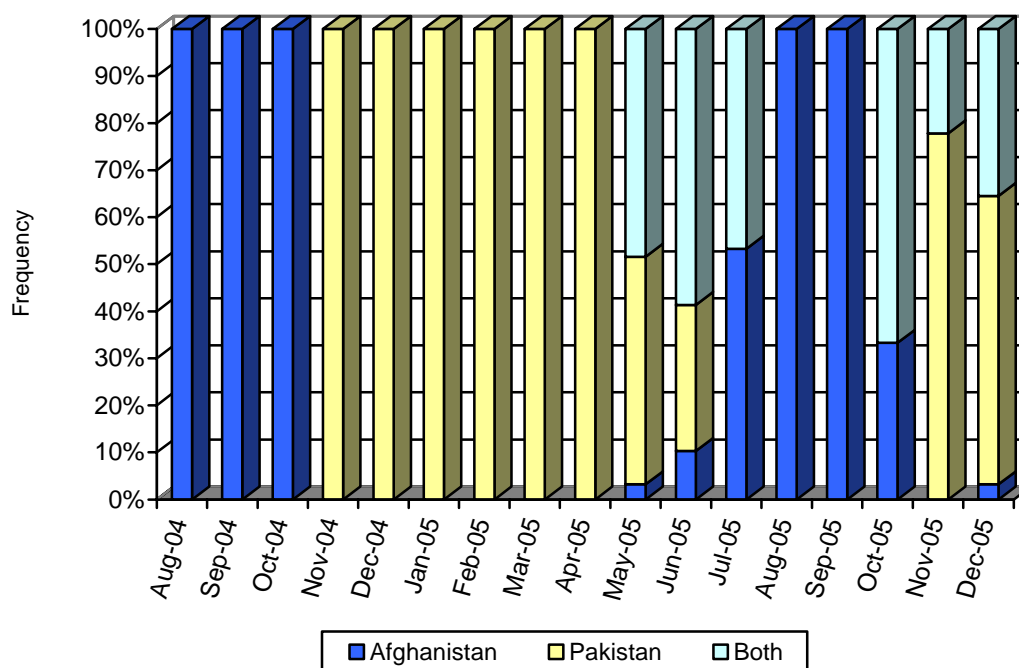


Figure 2: Distribution of cucumber supplies in Kabul by source



3.1.2 Price forecasting model for cucumber

An inverse demand function relating price levels to quantity supplied was estimated using Ordinary Least Square method. After the determination of the lag structure of price and quantity in the model, the later was tested for autocorrelation and heteroscedasticity. The Durbin Watson h-statistic equals 18.79 and is greater than the critical value of 1.96. Similarly, calculated Box Pierce Q-statistic equals 70.51, which is greater than the critical value of 37.57 with degree of freedom of 20 in the Chi-square distribution table. Therefore, results from both tests reject the null hypothesis of no autocorrelation in the error terms. For the test of homoscedasticity, the LM-statistic equals 7.48 and is greater than the critical value of 5.99 at 95% confidence level. The null hypothesis of homoscedasticity is also rejected. Consequently, the model was re-estimated to include lagged residuals terms as explanatory variables and using the Weighted Least Square method. The weighting variable is the inverse of the squared quantity of vegetable sold by market commissioners. Results of the model are presented in Table 1. These results show the negative correlation between cucumber price and its quantity supplied to the market daily, and an adjustment mechanism between the current and previous day prices. The coefficients on most residual terms are significantly different from zero confirming the moving average process of the price series. Furthermore, the estimated model was used jointly with supply data to forecast cucumber prices in subsequent periods from the first to the fifteen of January 2006 which is outside the original sample. Two forecasts were conducted: a myopic forecast which is based on previous forecasted prices and information-updated forecast that is based on actual prices in preceding days. The resulting forecasts are plotted against actual prices (Figure 3). The plots show that the myopic model forecast relatively well the price for the first 8 days into 2006. Beyond that time, its accuracy decreases over time as the forecast errors cumulate during the estimation of subsequent prices. The information updated forecast did even better compared to the myopic model. Thus the model developed in this study could be used to forecast market prices for cucumber.

Table 1: Weighted Least Square results of cucumber price model

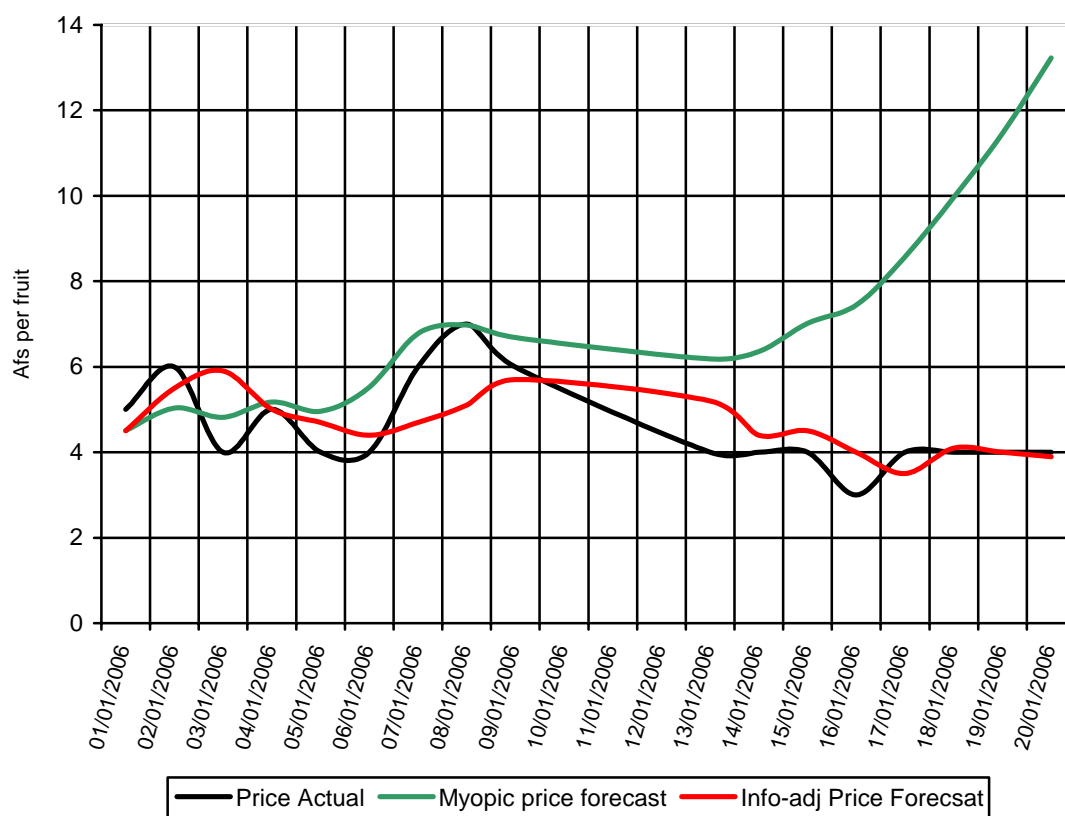
	Coefficient	t-ratio	P-value
Constant	0.653	1.856	0.0634
Quantity _(t)	-0.000026	-2.255	0.0241
Quantity _(t-1)	-0.000013	-0.982	0.3263
Quantity _(t-2)	0.00002	1.196	0.2319
Quantity _(t-3)	0.0000035	0.292	0.7703
Quantity _(t-4)	-0.000005	-0.991	0.3217
Price _(t-1)	0.9032	9.860	00000
Residual _(t-1)	-0.486	-4.342	0.00001
Residual _(t-2)	-0.061	-0.609	0.5424
Residual _(t-3)	0.102	1.303	0.1927
Residual _(t-4)	0.122	2.018	0.0435
Residual _(t-5)	0.092	1.815	0.0696
Residual _(t-6)	0.071	1.719	0.0857
Residual _(t-7)	0.088	2.626	0.0086
Residual _(t-8)	0.047	1.988	0.0468
Adjusted - R ²	0.77		

Table 2: Actual and forecasted cucumber daily prices (Afs per fruit)

Date (out of sample)	Actual Price	Myopic Price Forecast	Information up-dated Forecast	Deviation from actual ¹
01 January 2006	5	4.5	4.5	0.5
02 January 2006	6	5.0	5.5	0.5
03 January 2006	4	4.8	5.9	-1.9
04 January 2006	5	5.2	5.0	0.0
05 January 2006	4	5.0	4.7	-0.7
06 January 2006	4	5.5	4.4	-0.4
07 January 2006	6	6.8	4.7	1.3
08 January 2006	7	7.0	5.1	1.9
09 January 2006	6	6.7	5.7	0.3
10 January 2006	4	6.2	5.2	-1.2
11 January 2006	4	6.4	4.4	-0.4
12 January 2006	4	7.0	4.5	-0.5

Notes: 1. Deviation between actual price and information updated forecast

Figure 3: Actual versus forecasted daily prices of cucumber



3.2 Tomato

3.2.1 Tomato supplies and price dynamics

Tomato supplies to Kabul main market declined steadily from the average of 2012 tons in August to 312 tons in November 2004. It remained more or less stable till March 2005 (384 tons) and increased to its peaks of 3290 tons and 3020 tons in June and July 2005 respectively (Figure 4). The volume of supply took a downward turn from these peaks during the second half of the year to 658 tons in November with a slight recovery in December to 1555 tons.

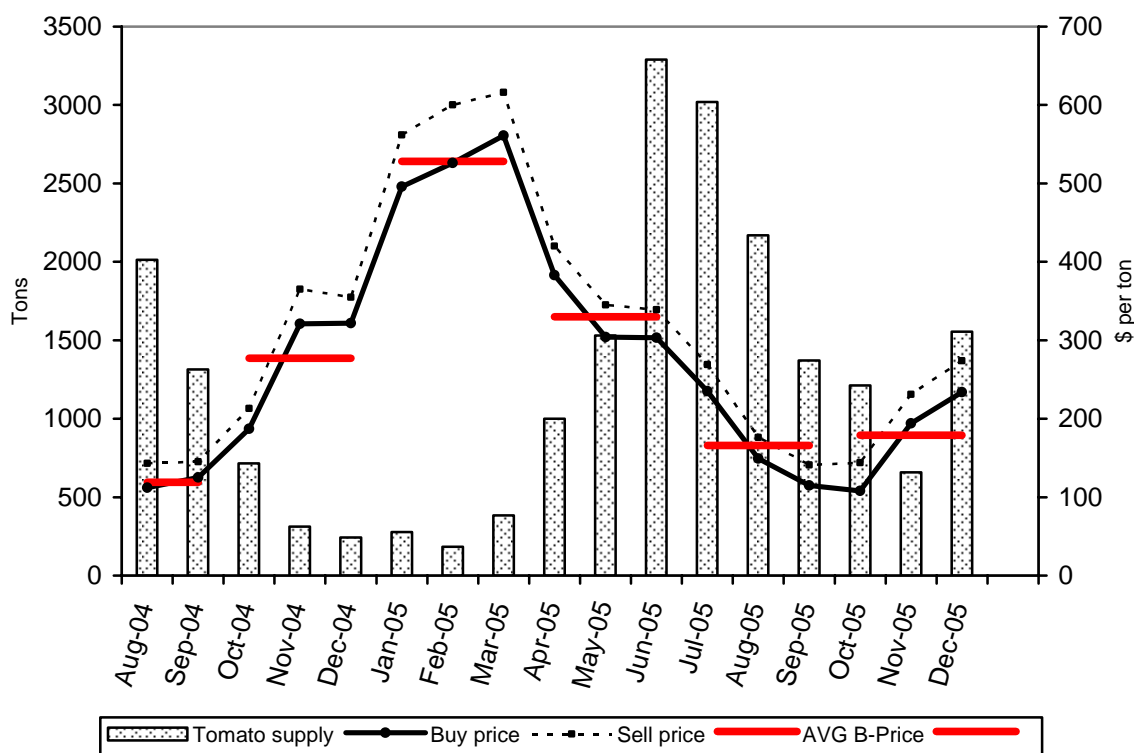
In terms of sourcing tomato was supplied to Kabul mainly from Pakistan between December 2004 and May 2005. The pattern of high dependence on Pakistan in winter months is repeated towards the end of the data series in November and December 2005 where the frequencies are either high for Pakistan or for both sources. This trend is completely reversed between August and October when local production predominated on the market (Figure 5).

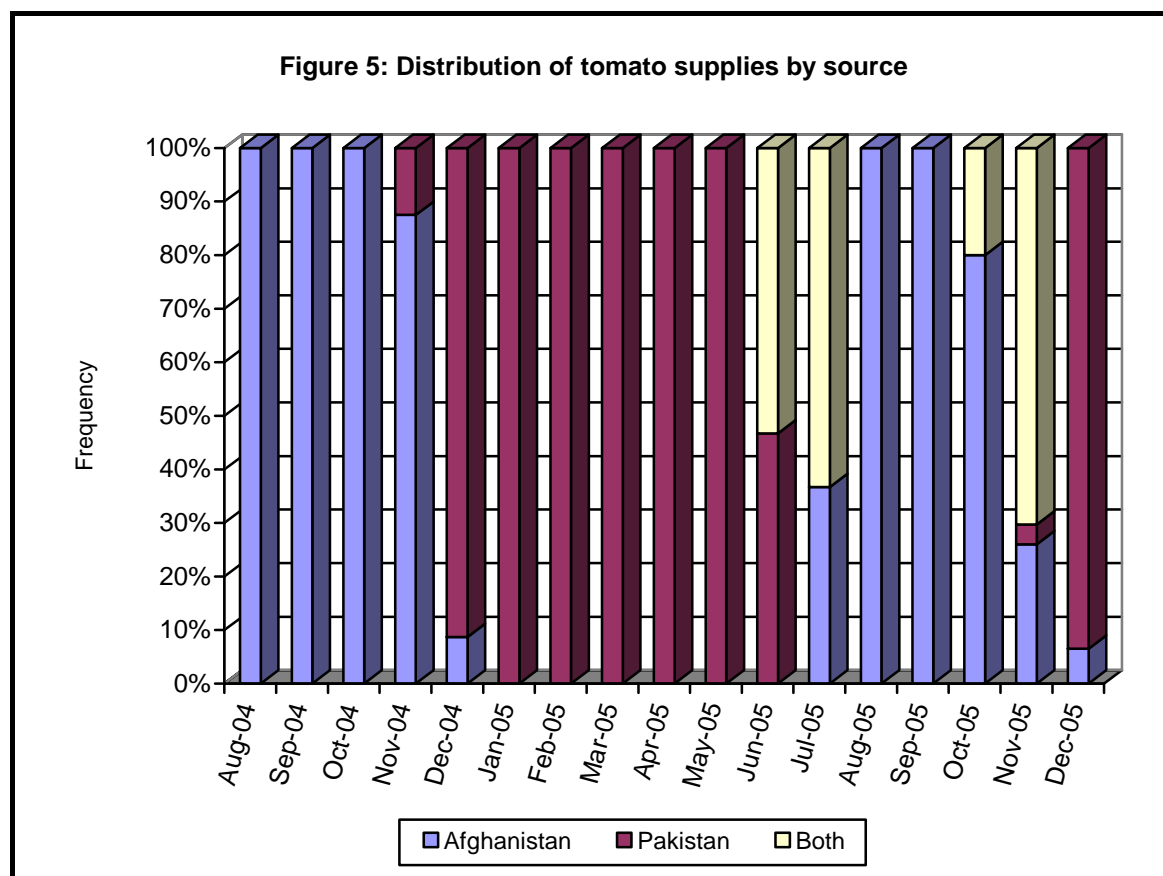
Prices increased steadily from \$112 to \$561 per ton between August 2004 and March 2005 as supply declined. Between April and October 2005 prices declined as supply culminated at its highest in June and also declined thereafter. The market seemed saturated or oversupplied between July and October 2005 as both supply and prices jointly followed a downward trend. This could be due to market participants' expectation that supply will continue to rise during these warm months and prices declined even though expectations about supply did not realized. Another explanation is the slow down the market absorption rate leading to day to day accumulation of unsold stock of fruits which increases losses, further lowers traders' demand and depresses prices. Furthermore, the May-July period corresponds to the time when market demand is likely to be low because of home-grown, kitchen garden, fresh tomato harvests by some households or consumer groups. An upward trend in price was observed in November and December 2005, increasing from \$194 to \$234 per ton

respectively while supply also increased slightly. The first quarter of the year corresponding to winter months is the period of the year when prices are highest, averaging \$528 per tons followed by the second (\$330 per ton) and the last quarters (\$179 per ton). Coincidentally, the first and second quarters are the periods when tomato is supplied mainly from Pakistan. Ideally, these periods would represent a marketing window for marketing fresh tomatoes from greenhouse production.

The production cycle of tomato is about 80 to 90 days for the vegetative stage and a period of 12 months of fruiting and harvesting. It would be advisable to plant the crop in greenhouses in August when prices are the lowest; produce harvest and sales could start at the beginning of November and into the following year. However, this strategy requires adequate crop management practices in winter. Because of the long harvesting period for tomato, it is technically impossible to introduce another crop in rotation with tomato unless the production-harvesting period is shortened. Therefore, a grower has the option between growing tomato that will occupy the greenhouse structure for the whole year or other vegetables. However, the appropriate decision could not be made based on market prices alone.

Figure 4: Tomato supply and price dynamics in Kabul, Afghanistan





3.2.2 Price forecasting model for tomato

An adaptive model depicting daily tomato price as a function of current quantities of fruit supplied and lagged price variable was estimated using daily observations from August 2004 to December 2005. The initial model was tested for autocorrelation and heteroscedasticity. Calculated Box Pierce Q-Statistic is 22.34, which is smaller than the critical Chi-square value of 37.57 with 20 degrees of freedom. Therefore, one could not reject the null hypothesis of no autocorrelation in the error terms. On the contrary, calculated LM statistic of 56.26 is greater than Chi-square critical value of 9.21 at 99% confidence level and therefore, the null hypothesis of homoscedasticity is rejected. As such, the price equation for tomato was estimated using weighted Least Square method, the weight being the natural logarithm transformation of the squared quantity sold daily by market commissioners. The estimated model is highly significant statistically as shown by the joint test of model coefficient (F-statistic) and the adjusted R-squared. As one would expect, results show that tomato price decrease as its supply increases. However, the current price response to a direct quantity change is very small as measured by the estimated coefficient, which represents the marginal effects. There is nearly no price response to quantity supplied in previous trading days as shown by non-significant coefficients on the lagged quantity variables. Yet, current prices adjust significantly and substantially to those of three preceding trading days.

The model results were used to derive a myopic and information updated price forecasts for tomato. Table 3&4 and Figure 6 below show the forecast results. Overall, the information updated forecast predicted very well tomato price in the market as opposed to the myopic forecast. This stress the need to update market information on realized prices in order to improve accuracy of model forecast. The information generated through this model could be used to improve tomato marketing decision by producers.

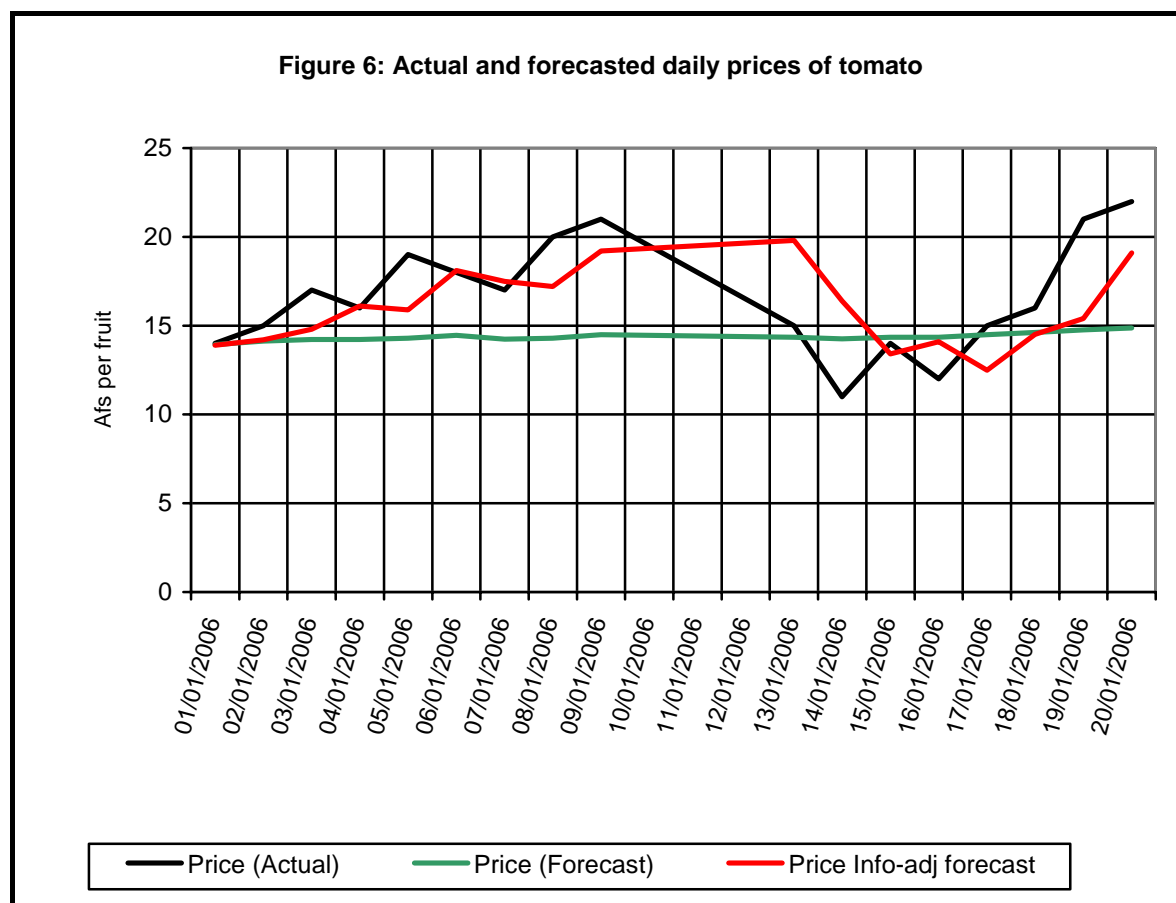
Table 3: Price model results for tomato

	Coefficient	t-ratio	P-value
ONE	0.928002	3.13	0.002
Quantity	-0.000015	-4.10	0.000
Quantity _(t-1)	0.000004	0.91	0.363
Quantity _(t-2)	0.000004	0.98	0.326
Price _(t-1)	0.651897	14.99	0.000
Price _(t-2)	0.118843	2.31	0.021
Price _(t-3)	0.135365	2.66	0.008
Price _(t-4)	0.045190	1.07	0.285
R-squared	0.899		
F [7, 518]	667.56		0.000

Table 4: Actual and forecasted tomato daily prices (Afs per kg)

Date (out of sample)	Actual Price	Myopic Price Forecast	Information up-dated Forecast	Deviation from actual ¹
01 January 2006	14	13.93	13.9	0.067
02 January 2006	15	14.13	14.2	0.825
03 January 2006	17	14.22	14.8	2.207
04 January 2006	16	14.22	16.1	-0.141
05 January 2006	19	14.29	15.9	3.094
06 January 2006	18	14.45	18.1	-0.146
07 January 2006	17	14.24	17.5	-0.483
08 January 2006	20	14.29	17.2	2.776
09 January 2006	21	14.48	19.2	1.772
10 January 2006	15	14.35	19.8	-4.812
11 January 2006	11	14.26	16.4	-5.353
12 January 2006	14	14.35	13.4	0.550

Notes: 1. Deviation between actual price and information updated forecast



3.3 Egg plant supplies and price dynamics

For egg plant, August seems the single month of abundance when supply reached its largest levels of 1,721 tons in 2004 and 2,020 tons in 2005. Supply is relatively low between November 2004 and March 2005 (Figure 7). The pattern observed from April to September 2005 suggests two successive production seasons, one of which was delayed by two months with respect to the other, and as a result maximum supplies occurred in May and August. Supplies of 502 tons and 1,379 tons in the last two months of 2005 were higher compared to the levels in the same months in the previous year.

Market provision of egg plant was mostly sourced from Pakistan between November 2004 and May 2005. This was also repeated in November and December 2005. It originated from Afghanistan between July, August, September, and October of each year. Supply was shared unevenly between the two sources in the months of June, July, and October 2005 (Figure 8).

Prices of egg plant were high in the first quarter of 2005 and averaged \$196 per ton (Figure 7). They were at the intermediate level of \$178 per ton over April-June and \$178 per ton during October-December periods. The lowest prices were recorded in during July, August and September. This suggests that July-September is the period when egg plant supply is excessive compared to demand. There is a strong negative correlation of -0.4 between quantities supplied and prices, thus abiding to the law of demand, in this case that of market commissioners. The first semester of the year (January though June) seems the most appropriate period for growers to sell egg plant; therefore, planting could take place sufficiently ahead of that period in order to meet such a marketing window. Yet, the strategy has to accommodate greenhouse heating and cold stress management.

Figure 7: Egg Plant supply and price dynamics in Kabul, Afghanistan

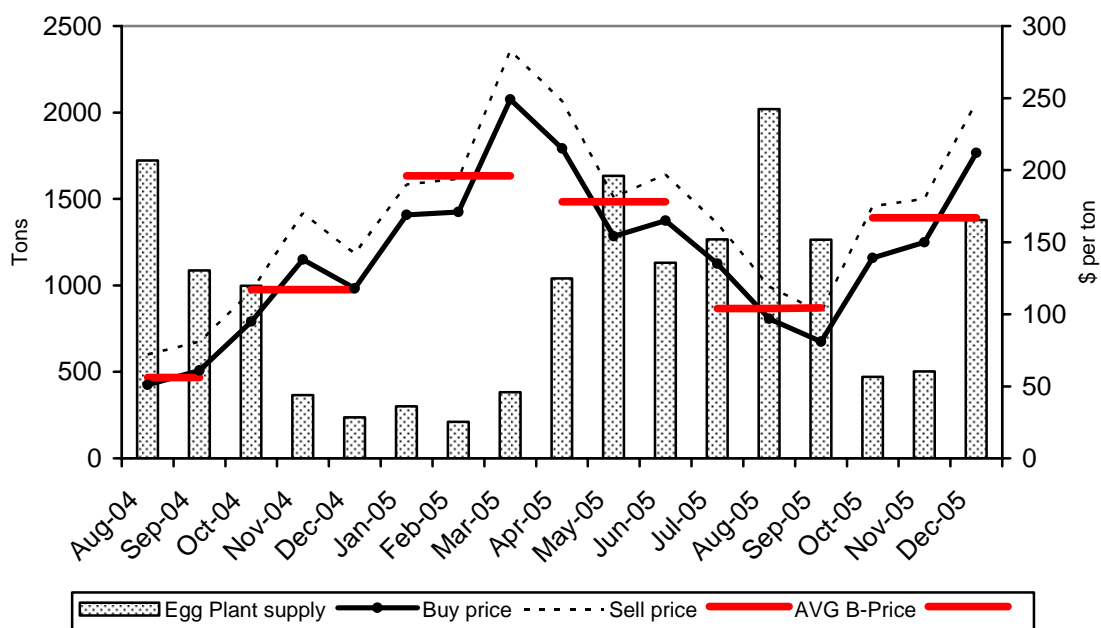
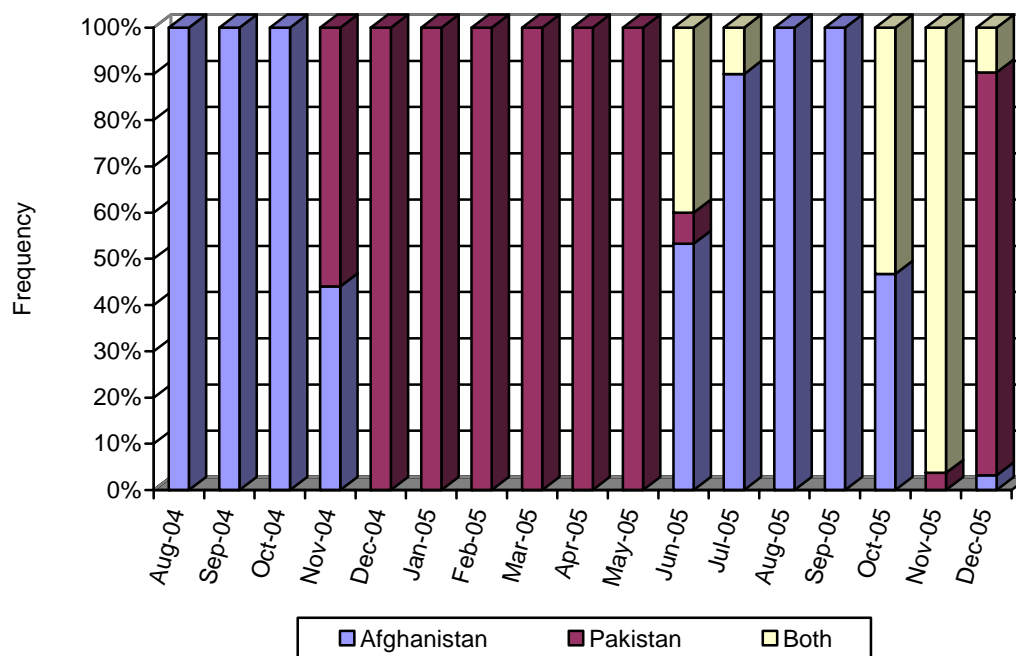


Figure 8: Distribution of egg plant supplies by source

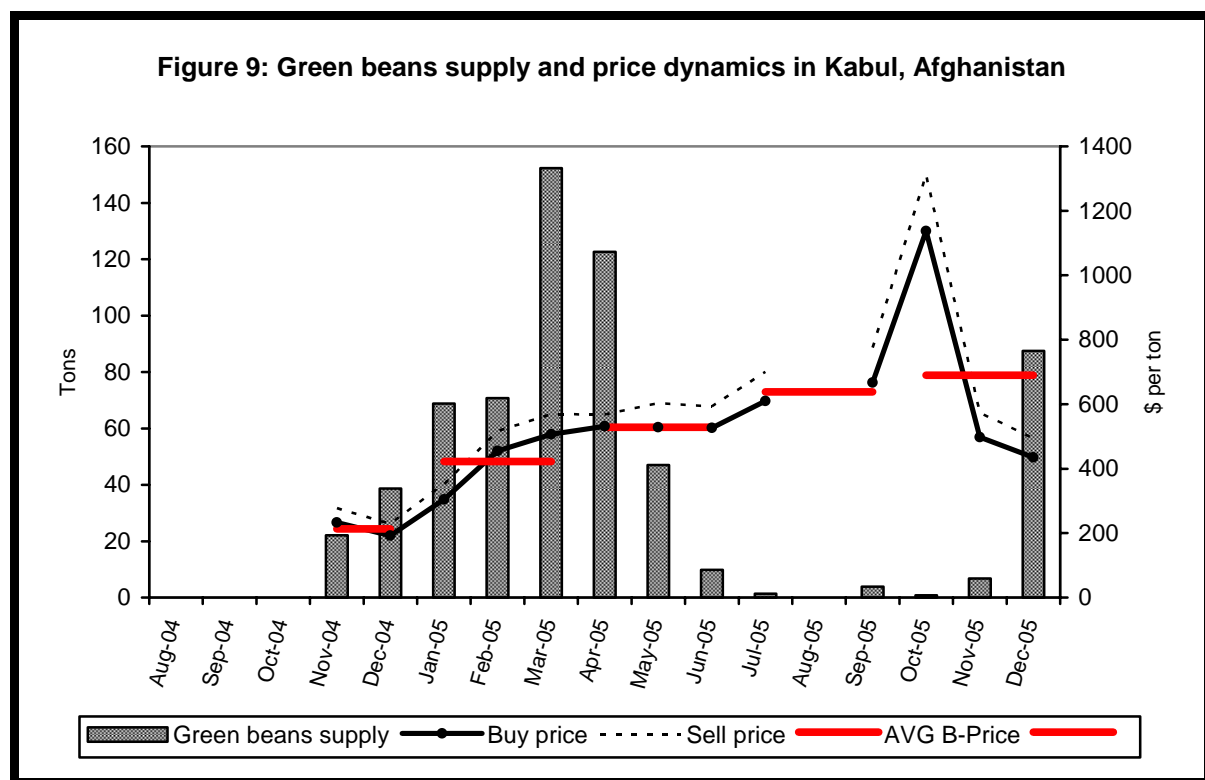


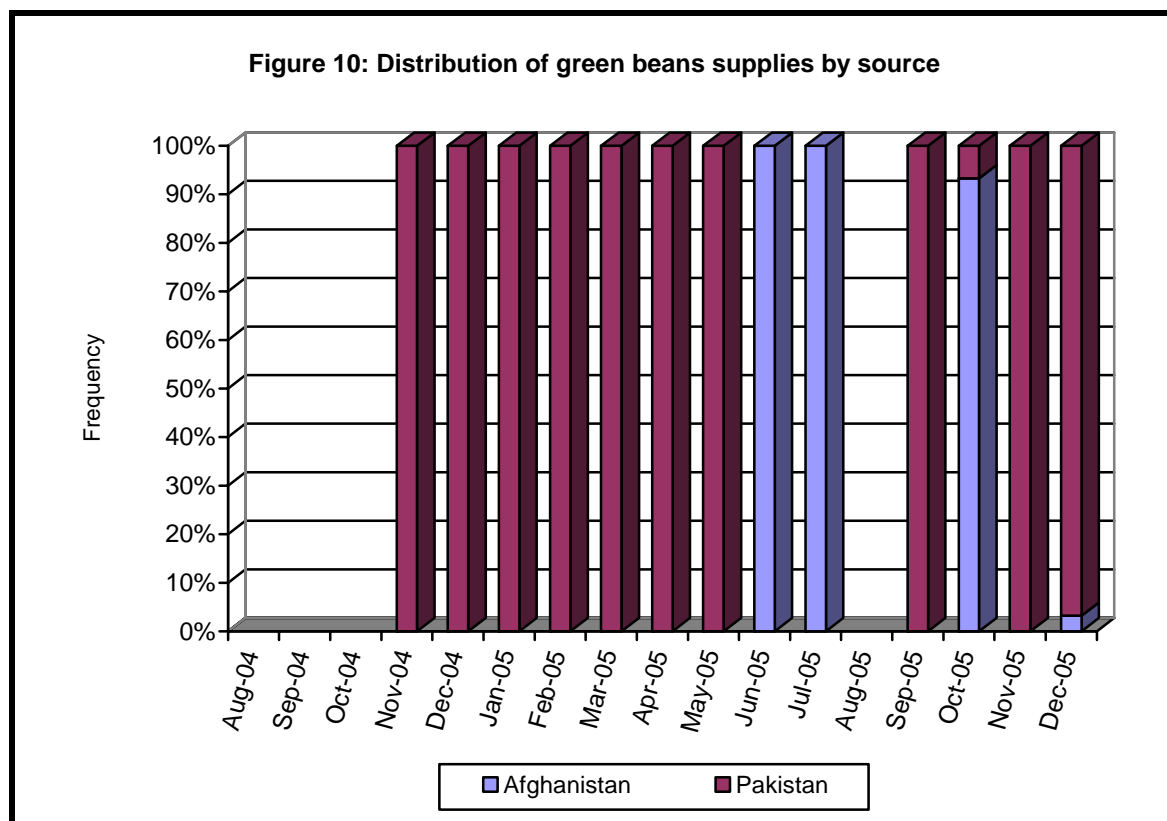
3.4 Green beans supplies and price dynamics

Green beans supply increased from about 22 tons in November to its maximum of 152 tons in March. This trend was reversed in subsequent months until its disappearance from the market in August. Supply remained very low in the following months but picked up eventually to reach 88 tons in December 2005 (Figure 9).

In August, September and October 2004 green beans were not available on the Kabul market. A similar observation was recorded in August 2005. Supply originated from Pakistan only from November 2004 till May 2005, and in September, November, and December 2005. The opposite where supply came from Afghanistan was observed in the months of June, July, and October 2005 (Figure 10). It is unclear which factors determined the month to month and even year to year production and supply of green beans in Afghanistan, and why these wide gaps were observed.

Green bean prices and quantities correlations followed two distinct and opposite patterns over the period studied. Between December 2004 through March 2005 prices and quantities increased simultaneously with a positive correlation coefficient of 0.82. However, the correlation is -0.44 between prices and quantities over the period of April to December 2005. This lack of systematic and consistent relationship between prices and quantities added to the disappearance of the produce and lack of price information make it difficult to determine the appropriate production and marketing strategy. Based on the market observations September and October seem to correspond to the period of high prices. Therefore, the dwarf green bean variety that matures after 45 days with harvesting spanning one month could be planted by mid-August.





3.5 Pepper supplies and price dynamics

Supply of pepper remained very low and ranged between 60 to 300 tons per month between August 2004 and March 2005 (Figure 11). It increased from 1184 tons in April 2005 to its maximum of 2772 tons in July before dropping sharply till in October 2005 to 297 tons. As observed in the previous year, supply of pepper remained low between October and November 2005 with yet a surge to 1201 tons in December. A similar rise was also recorded for cucumber.

Local supply of pepper to the market started in May 2005 and increased sharply to the maximum in August and September (Figure 12); it declined to its lowest level in December 2005. Between November 2004 and May 2005 the bulk of pepper sold in the market was sourced from Pakistan. The period of August to October is mainly the time when local pepper producers crowded out the Pakistanis. The reverse is true between December and April when pepper was mainly supplied from Pakistan.

Figure 11 also shows the negative relationship between monthly quantities of pepper handled by market commissioners and prices. The latter increased from \$188 to \$363 per ton between August and October 2004, declined thereafter to \$134 in December when supply conditions improved. The price increased sharply from \$269 in January to \$1180 per ton in March 2005, a period of erratic supply; it declined again sharply between April and May to \$306 per ton. The price somehow stabilized between May and June before taking a downturn till September 2005 to reach \$188 per ton. As supply shortened in October, buying price increased suddenly before declining in November and December when supply increased again. The average buying price between January and April 2005 corresponding also to the time when traders from Pakistan mostly sent supplies to Afghanistan is \$659 per metric ton whereas it dropped to the level of \$261 per ton between May and September 2005 when local production is predominant in the market. Under normal condition and proper crop management in the greenhouse, the vegetative growth period for pepper varies from 80 to 90 days, and harvesting could take up to 12 months period. Therefore, planting in July to start harvesting in October throughout May or beyond would be the most appropriate strategy for farmers who have adopted the greenhouse technology. Because of the long harvesting period for pepper, rotation with other crops within one year time frame is quite impossible.

Figure 11: Pepper supply and price dynamics in Kabul, Afghanistan

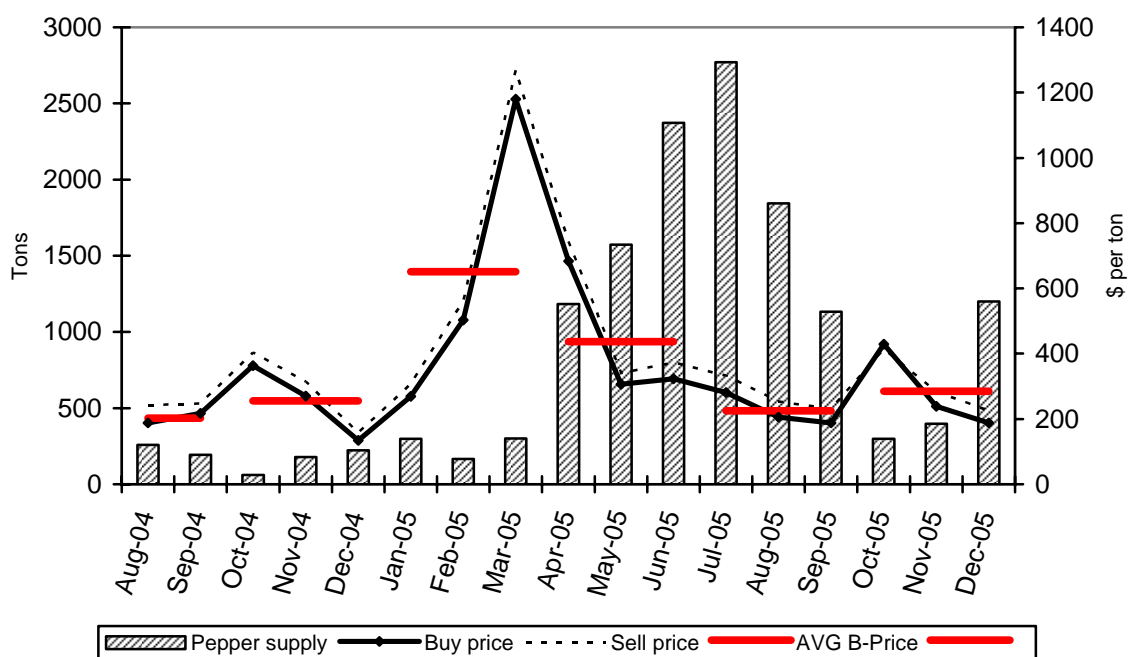
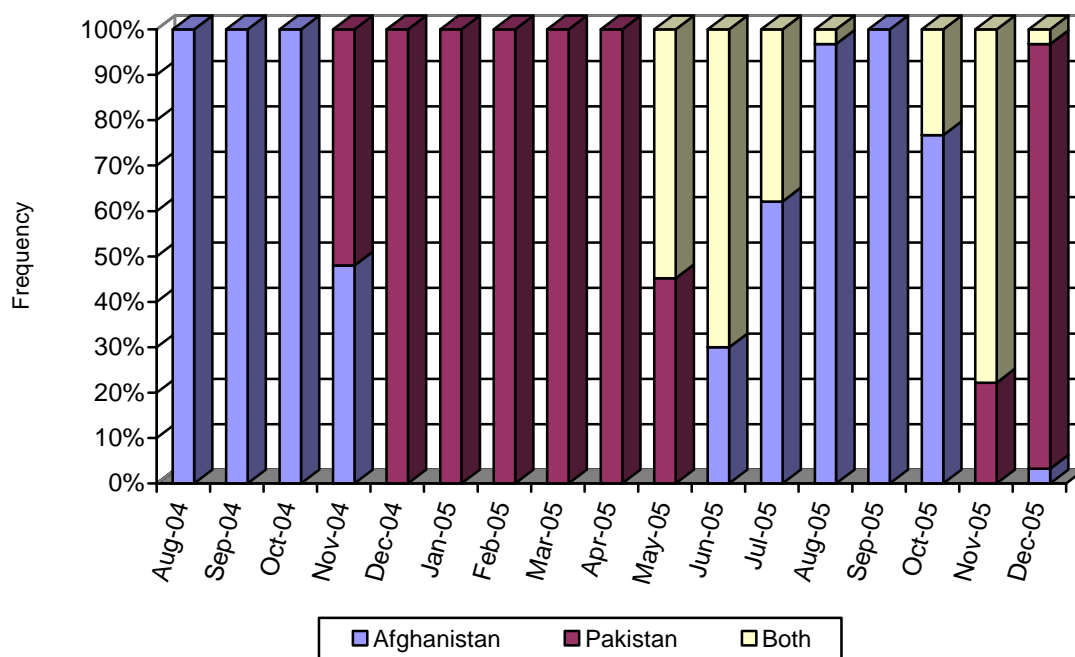


Figure 12: Distribution of pepper supplies by source



3.6 Squash supplies and price dynamics

Supply of squash to Kabul market was very low during the second half of 2004, between 14 and 254 tons per month, and in the first quarter of 2005. It increased steadily from 343 tons in March to the

peak of 3215 tons in June 2005. This trend reversed thereafter and supply dropped gradually to 272 ton and 394 tons in November and December 2005 respectively. Over the last 12 months of the period of observation, May, June and July corresponded to the period of relative abundance of squash (Figure 13). Coincidentally, this is also the period when squash is sourced from both Afghanistan and Pakistan. From October 2004 till April 2005, supply of squash originated mainly from Pakistan. This pattern was repeated towards the end of the data series in November and December 2005 (Figure 14). In August and September of 2004 supply was entirely local whereas in 2005 there was no single month when it was the case.

The market prices and quantities supplied are negatively related with a correlation coefficient of -0.30 implying generally that prices were lowered when quantities supplied increased. In accordance with supply dynamics, the price of squash increased from \$65 to \$259 per ton between August and October 2004, declined nearly to its August level in December. The first quarter of 2005 represents the period of high prices, on average \$318 per ton followed by the fourth quarter when prices were intermediate (\$245 per ton). Coincidentally, these are the period when supply mostly originated from Pakistan. June, July and August recorded the lowest average prices around \$150 to \$179 per ton, and local supply predominated in the market (Figure 14).

Squash production requires 40 to 45 days for vegetative growth before reaching maturity and fruit harvesting covers a period of 1.5 months. In order for growers to take advantage of high market prices, planting should occur in December for February-March sales. Alternatively, squash could be planted in July for October-November sales when prices are the highest.

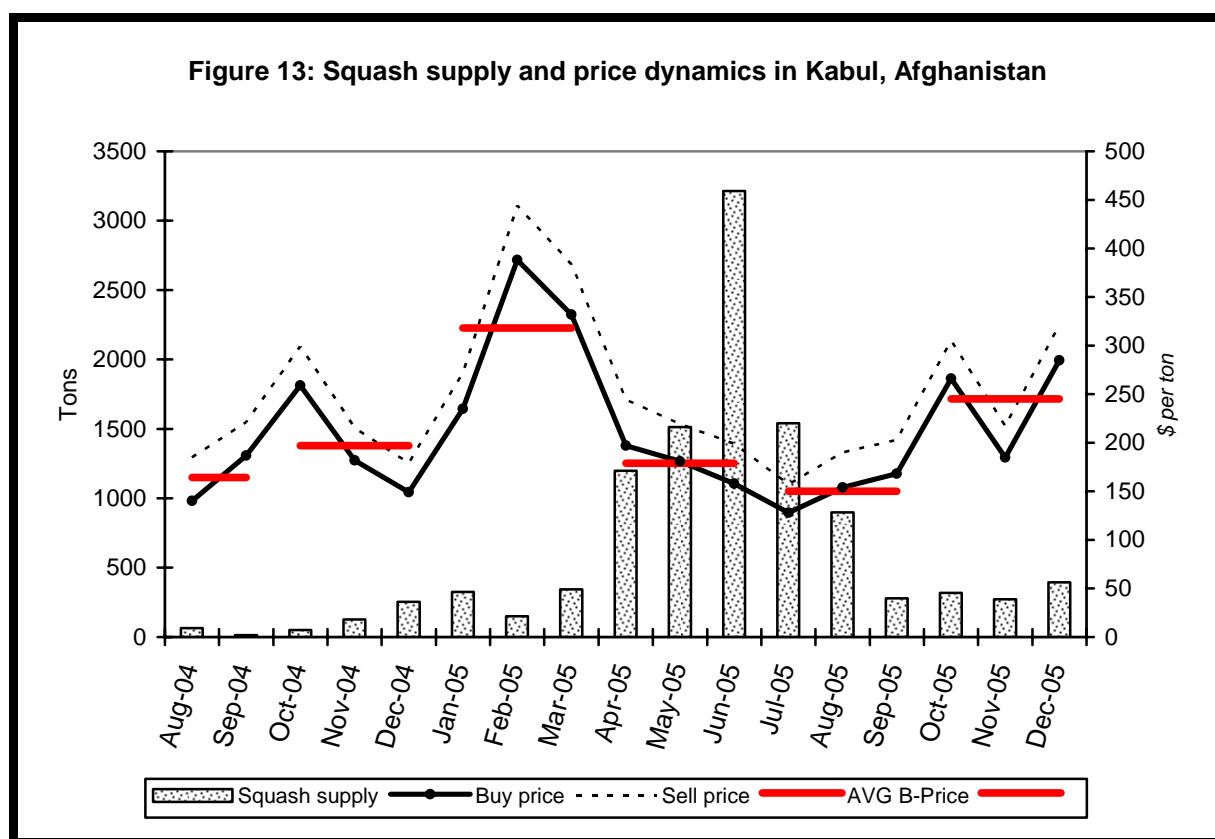
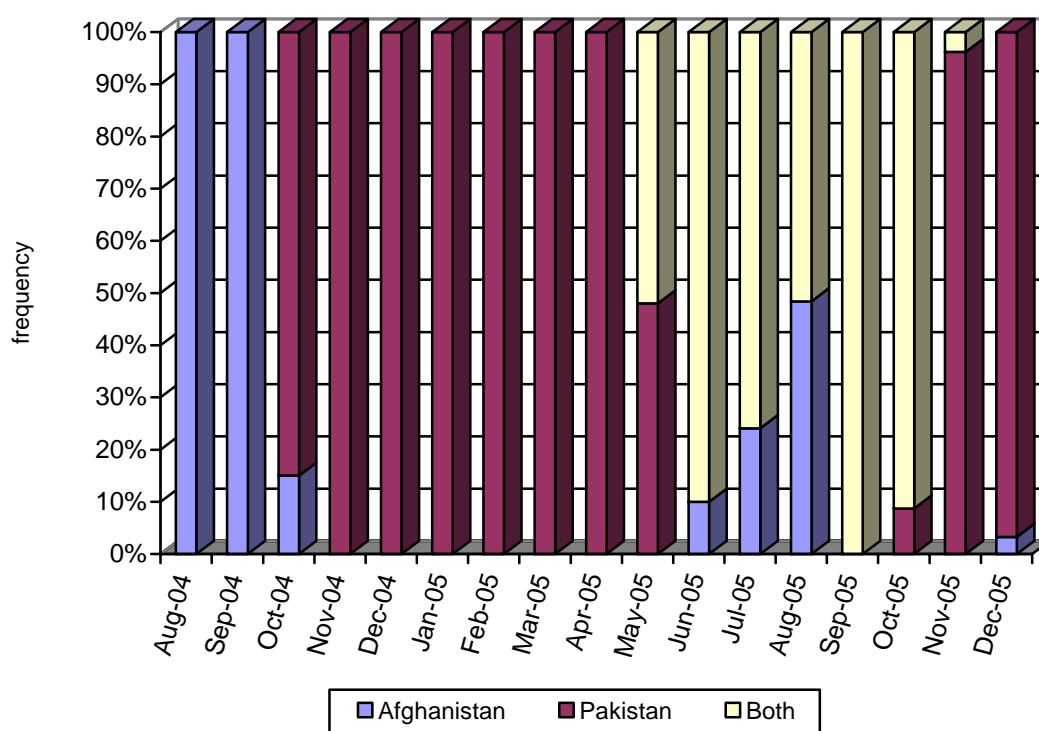


Figure 14: Distribution of squash supplies by source



3.7 Sweet pepper supplies and price dynamics

Sweet pepper supply declined between August and October 2004 from 139 to 66 tons, followed up and down turns from one month to the other between October and February 2005 (Figure 15). It increased from 61 tons in February to a maximum level of 244 tons in April 2005. The volume seemed to stabilize around 220 tons till June before dropping to the lowest level in the three month period of July and August 2005, hovering between 65 and 77 tons. Supply in the last quarter of 2005 ranged between 168 and 263 tons, and was at an unexpectedly high level compared to the same quarter in previous year.

Between November 2004 and April 2005, the Kabul vegetable market was mostly supplied with sweet pepper from Pakistan. The pattern of high dependence on Pakistan in winter months is repeated towards the end of the data series in November and December 2005 where the frequencies are either high for Pakistan or for both sources. Sweet pepper supplies originated solely from Afghanistan between August and September (both in 2004 and 2005), and shared unevenly between the two sources in the months of June, July, and October 2005 (Figure 16).

Unlike many other vegetables, the price of sweet pepper was more stable during much of the period studied. The lowest monthly average price of \$42 per 1000 pieces was observed over the period of April-June 2005. Prices were intermediate between October 2004 and March 2005, and July - September 2005. The highest prices were observed in August-September 2004 as well as the last quarter of 2005 (\$72 and \$82 per 1000 pieces respectively). The gap between high and low prices is not substantial reflecting the stability of sweet pepper supply as mentioned earlier. Wherever possible, local growers should try to grasp the supply away from Pakistanis in the periods when prices are intermediate or high i.e. July through March. Growers could plant the crop in May and start harvest and sales in July.

Figure 15: Sweet pepper supply and price dynamics in Kabul, Afghanistan

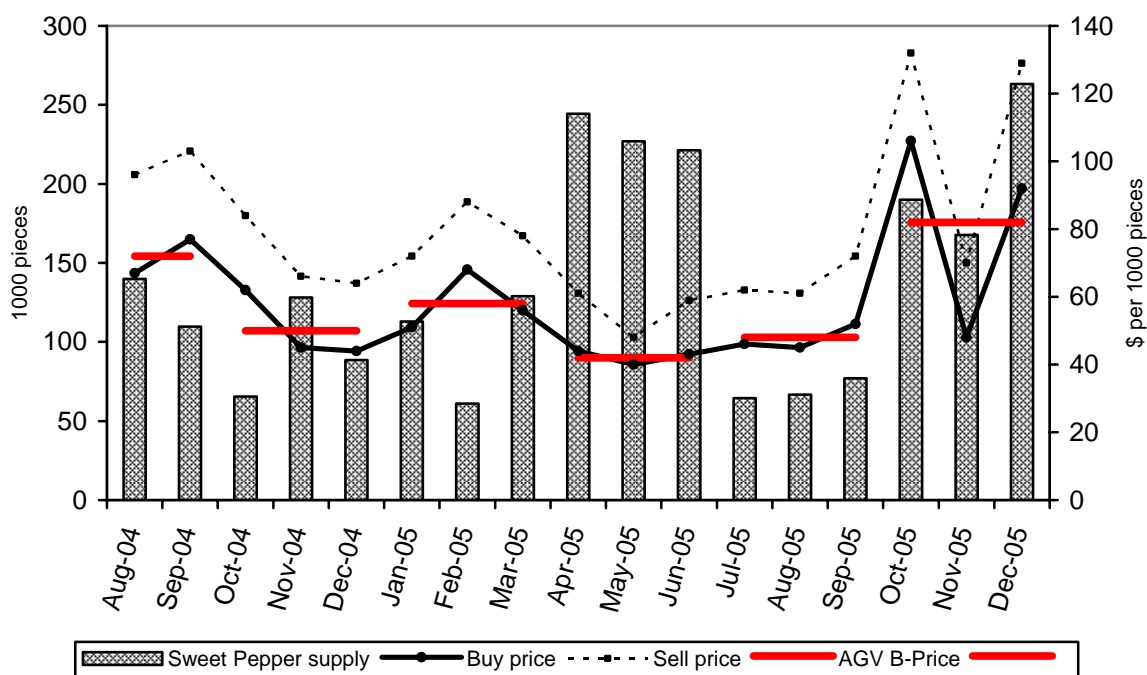
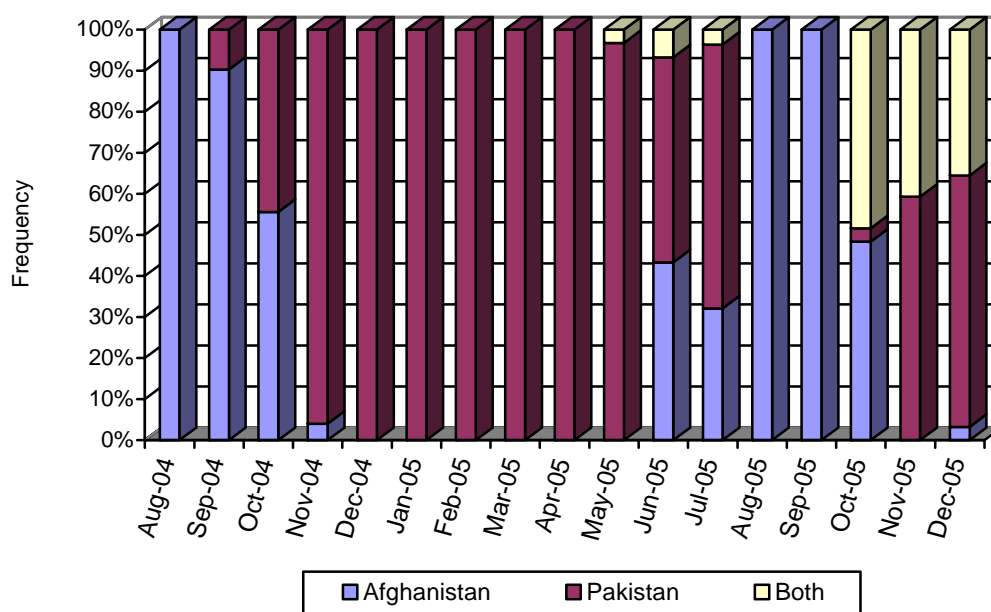


Figure 16: Distribution of Sweet pepper supplies by source



Conclusion and implication for Afghan vegetable growers

From the above results it can be generally said that vegetable supplies come mainly from Pakistan to Kabul market between November and April of the subsequent year, a period that corresponds to the coldest months of the year. Spring season production of vegetable in Afghanistan that is harvested in the summer (May, June and July) coincides with supplies from Pakistan. Therefore, market demand is shared among the two sources. Summer productions of vegetable that are harvested and marketed in August, September, and to some extents in October tend to crowd Pakistan traders out of the local market.

The implication for the Afghan vegetable grower who has adopted the greenhouse technology, yet without full capacity or heating system to be able to produce during winter, is that there may be an opportunity to compete and increase market share for vegetables by extending harvests into November and part of December. Alternatively, he could adopt an early spring planting strategy (in late February through March) when the cold temperature does not reach extreme levels, in order to harvest in May-June. Both strategies require an increase in efficiency of operations that minimizes production costs and confers to the local grower a competitive advantage over Pakistan rivals. However, there is a potential risk of having a couple of night frosts during these periods. Therefore, the strategy will require strengthening the skills and capacity of the grower to manage the greenhouse structure properly to avoid produce losses due to frosts or any other factors, and to minimize per unit of production costs. At the time of this analysis data on the fixed and variable production costs, and the gross margins of the respective crop were not available. As such an analysis that considers crop rotation schemes to maximize growers' income will be performed when such data is gathered.

A comparison of price forecasting models for cucumber and tomato provide evidence of the necessity to continuously update market information on prices in order to project a more accurate future price forecast. These models could be used by marketing extension agents as well as project staff to help greenhouse vegetable growers improve their production and marketing decisions.

References

- Food and Agricultural Organization of the United Nations (FAO), 2000. Food Security through Sustainable Crop Production in Afghanistan. Technical Report.
- Granger, Clive W.J. and Paul Newbold, 1986. Forecasting Economic Time Series. New York: Academic Press.
- Greene, H. William, 1998. Limdep version 7.0. Users' manual revisited; Econometric Software, inc., Plainview, 825 pp.
- Greene, H. William, 1993. Econometric Analysis. Second Edition. Prentice Hall, Inc. New Jersey, 784 p.
- Nejatian, Arash, 2004. Mission reports, ICARDA Arabian Peninsula Regional Program, Dubai, UAE.

APPENDIX

Table 5: Detailed counts of data observation on prices and quantities (by crop and month)

Month-Year	Crop							Total
	Cucumber	Egg Plant	Green Beans	Pepper	Squash	Sweet Pepper	Tomato	
Aug-04	31	31		31	30	31	31	185
Sep-04	31	31		30	29	31	31	183
Oct-04	27	27		27	20	27	27	155
Nov-04	25	25	11	25	25	25	24	160
Dec-04	23	23	21	23	23	23	23	159
Jan-05	26	26	23	26	26	26	26	179
Feb-05	28	28	28	28	28	28	28	196
Mar-05	30	30	30	29	30	30	30	209
Apr-05	30	30	28	30	30	30	30	208
May-05	31	31	26	31	31	31	31	212
Jun-05	29	30	18	30	30	30	30	197
Jul-05	30	30	2	30	29	28	30	179
Aug-05	31	31		31	31	31	30	185
Sep-05	29	29	20	29	27	29	29	192
Oct-05	30	30	15	30	23	31	30	198
Nov-05	27	27	8	27	26	27	27	196
Dec-05	31	31	31	31	30	31	31	246
Total	489	490	261	488	468	489	488	3239

Table 6: Average daily volumes of vegetable traded by market commissioners

Month-Year	Crop						
	Cucumber (pieces)	Egg Plant (Kg)	Green Beans (Kg)	Pepper (Kg)	Squash (Kg)	Sweet Pepper (pieces)	Tomato (Kg)
Aug-04	6726	55522		8292	2166	4515	64908
Sep-04	3084	35027		6444	493	3540	42393
Oct-04	7789	36929		2273	2579	2429	26466
Nov-04	13536	14604	2009	7140	5056	5128	12996
Dec-04	5100	10261	1838	9652	11057	3852	10522
Jan-05	6623	11554	2991	11438	12519	4350	10673
Feb-05	3782	7511	2525	5936	5346	2184	6571
Mar-05	5623	12773	5077	10348	11440	4297	12783
Apr-05	31683	34650	4379	39467	39900	8150	33367
May-05	52258	52710	1810	50774	48806	7323	49323
Jun-05	127069	37667	550	79067	107167	7380	109667
Jul-05	221833	42167	675	92400	53103	2304	100667
Aug-05	33629	65161		59500	28935	2153	72333
Sep-05	9559	43576	195	39034	10354	2653	47300
Oct-05	14014	15703	52	9905	13772	6131	40433
Nov-05	15989	18589	845	14683	10458	6211	24356
Dec-05	38719	44487	2822	38732	13127	8494	50168

Table 7: Average daily buy-prices of vegetable by market commissioners

Month-Year	Crop						
	Cucumber (Afs /fruit)	Egg Plant (Afs /Kg)	Green Beans (Afs /Kg)	Pepper (Afs /Kg)	Squash (Afs /Kg)	Sweet Pepper (Afs /piece)	Tomato (Afs /Kg)
Aug-04	2	3		9	7	3	6
Sep-04	4	3		11	9	4	6
Oct-04	6	5		18	13	3	9
Nov-04	4	7	12	13	9	2	16
Dec-04	4	6	10	7	7	2	16
Jan-05	4	8	15	13	12	3	25
Feb-05	3	9	23	25	19	3	26
Mar-05	3	12	25	59	17	3	28
Apr-05	3	11	27	34	10	2	19
May-05	2	8	26	15	9	2	15
Jun-05	2	8	26	16	8	2	15
Jul-05	2	7	31	14	6	2	12
Aug-05	2	5		10	8	2	7
Sep-05	3	4	33	9	8	3	6
Oct-05	4	7	57	21	13	5	5
Nov-05	3	8	25	12	9	2	10
Dec-05	4	11	22	9	14	5	12

Table 8: Total volumes of vegetable handled monthly by the commissioners

Month-Year	Cucumber	Egg Plant	Green Beans	Pepper	Squash	Sweet Pepper	Tomato
Aug-04	208500	1721180		257053	64992	139967	2012150
Sep-04	95600	1085830		193312	14305	109725	1314180
Oct-04	210300	997090		61370	51580	65570	714570
Nov-04	338400	365100	22100	178500	126400	128200	311900
Dec-04	117300	236000	38600	222000	254300	88600	242000
Jan-05	172200	300400	68800	297400	325500	113100	277500
Feb-05	105900	210300	70700	166200	149700	61150	184000
Mar-05	168700	383200	152300	300100	343200	128900	383500
Apr-05	950500	1039500	122600	1184000	1197000	244500	1001000
May-05	1620000	1634000	47050	1574000	1513000	227000	1529000
Jun-05	3685000	1130000	9900	2372000	3215000	221400	3290000
Jul-05	6655000	1265000	1350	2772000	1540000	64500	3020000
Aug-05	1042500	2020000		1844500	897000	66750	2170000
Sep-05	277200	1263700	3900	1132000	279550	76950	1371700
Oct-05	406400	471100	775	297150	316750	190060	1213000
Nov-05	431700	501900	6760	396450	271900	167700	657600
Dec-05	1200300	1379100	87480	1200700	393800	263300	1555200